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Yarway Impulse Steam Trap with new stainless steel body.

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Then they keep it *continuously* at peak operating temperatures for maximum production. More extra profits!

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Try a Yarway today . . . standardize on Yarways tomorrow.

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Nest of Yarway traps installed with Yarway Strainers on cloth dryer. Note small space required.

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President A. L. BURNS, General Manager

VOLUME 29, No. 8 AUGUST, 1950

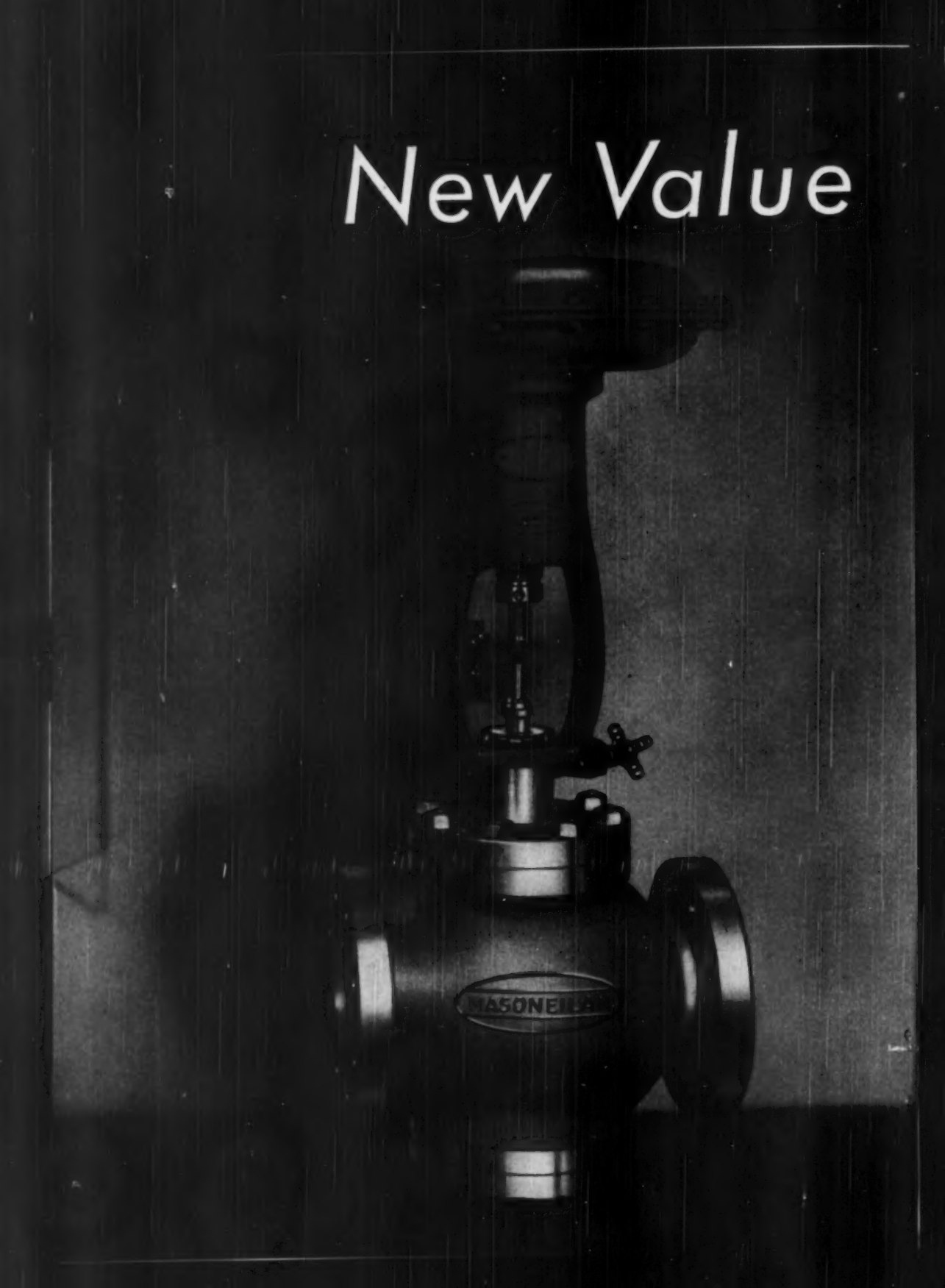
Contents

- **Oil Industry Makes Effective Use of Its Capital Setup** 67
  A study is presented of the financial structure of 30 oil companies.
- **Maintenance and Repair of Refinery Control Valves** 77
  Control valves, since they perform a task of vital importance in process plant operation, deserve regular and adequate maintenance attention.
  W. H. Fortney and C. C. Pryor
- **Propane Mixture Is Purified, Sweetened, and Dehydrated in One Continuous Operation** 83
  Propane, sometimes discarded into residue gas streams in refineries, often finds a profitable market that justifies expenditures for efficient recovery apparatus.
- **Reduced-Scale Methods for Micro and Semimicro Organic and Inorganic Analysis, Part I** 85
  Reduced scale analytical methods find good application in petroleum research laboratories in cases where samples are inherently too limited in amount for micromethods, or where other chemical microprocedures are too tedious or require very special sample preparation, or highly specialized apparatus and technique.
  Thomas D. Parks and Louis Lykken
- **Equipment Stresses Imposed by Piping** 89
  Cooperation between equipment manufacturers and piping designers can achieve worthwhile savings.
  F. W. Wolosewicki
- **Atomic Energy Developed As Important Oil Research Tool** ... 92
- **Bubble Tray Design and Layout, Part I** 93
  Sufficient information is presented to a two-part series to allow engineers not specialists in this field to design satisfactory bubble trays or to evaluate trays operating in plants.
  James K. Davies
- **Catalytic Cracking, Part II** 99
  Moving bed catalytic cracking units as contrasted to fixed bed units.
  Marshall Sittig
- **Refinery LPG Unit Employs Steam Jet Vacuum Refrigeration** . 105
  Refrigeration is finding increased use in process plants for the recovery and fractionation of light hydrocarbons.
  H. F. Thompson
- **High-Pressure Hydrogenation of Carbonaceous Matter, Part VIII. The Integrated Process** 107
  A discussion of the overall process facilities required in conjunction with hydrogenation is given both in terms of steel, equipment, and dollars investment. Also included are data on the cost of products.
  Peter W. Sherwood
- **Difficult Waste Disposal Problem Solved** 111
  Commercial operation has been achieved with flue gas serving for the neutralization of caustic waste products from refinery treating plants.
  Kenneth M. Brown and Sonia Kurtis
- **Bakersfield Refinery Modernized and Expanded** 116
  Principal process details of a newly rebuilt refinery.
- **Sour Gas—New Plant Operating MEA, Dehydration, Caustic, and Copper Chloride Units** 118
  Plant for the recovery of liquid hydrocarbons from casinghead gases, has initial capacity of 50 million cubic feet per day and has been designed so as to allow expansion to 100 million capacity with reasonable ease.
  M. H. Rahmes
- **Nomograph for Orifice Calculations** 123
  Flowmeter calculations are often tedious and time consuming. The nomographs presented here are intended to speed this work.
  Thomas H. Arnold
- **Solvent Lubricating Oil Plant Goes on Stream at Lima, Ohio** . 126

DEPARTMENTS

The Look Box 63
Refinery and Other Plant Construction 73
How to Do It 128
Refiner Authors and Other Personalities 132
The Month in the Industry 137
The Oil Man's Calendar 144
Science and Technology Abstracts 157
Compiled by Dr. E. H. Leslie and Dr. H. B. Coats
Digest of United States Patents Pertaining to Petroleum 167
Compiled by Heinz Heinemann
New Equipment, Manufacturers' Literature 183
Book Reviews 192
About Equipment and Service Suppliers 195
Index to Advertisers 202

New Value



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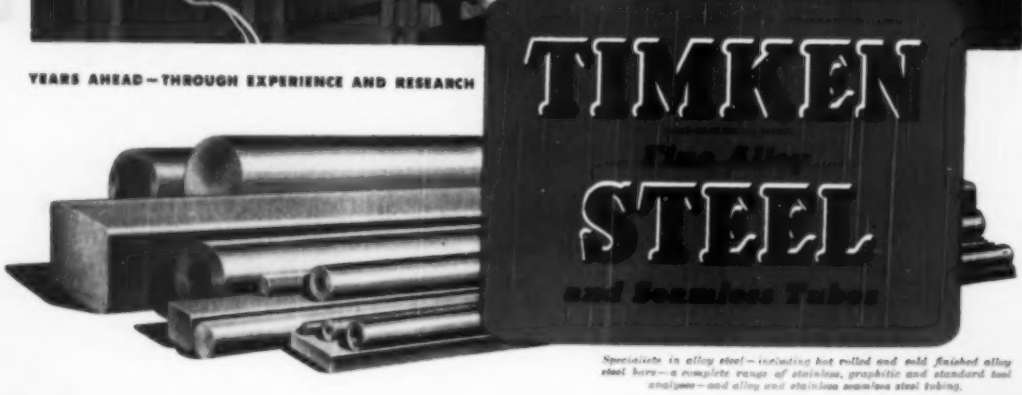
Timken was the first company to test high temperature steels, starting in 1920. Stress-rupture test (see below) was invented by metallurgists at Timken.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH



Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

THE Armstrong hardened chrome steel valve opens wide and closes tight — with a snap! This eliminates throttling and consequent wire drawing. The Armstrong free-floating lever mechanism is almost frictionless. The bucket and valve lever assembly are 18-8 corrosion resistant stainless steel. The mechanisms of Armstrong steam traps for low and medium pressures are identical in materials and workmanship to those used in Armstrong traps for pressures to 1500 psi, 900 F.

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THE 36-PAGE ARMSTRONG STEAM TRAP BOOK contains complete data on the design, operation, selection and installation of Armstrong steam traps for all services. Send for your free copy.

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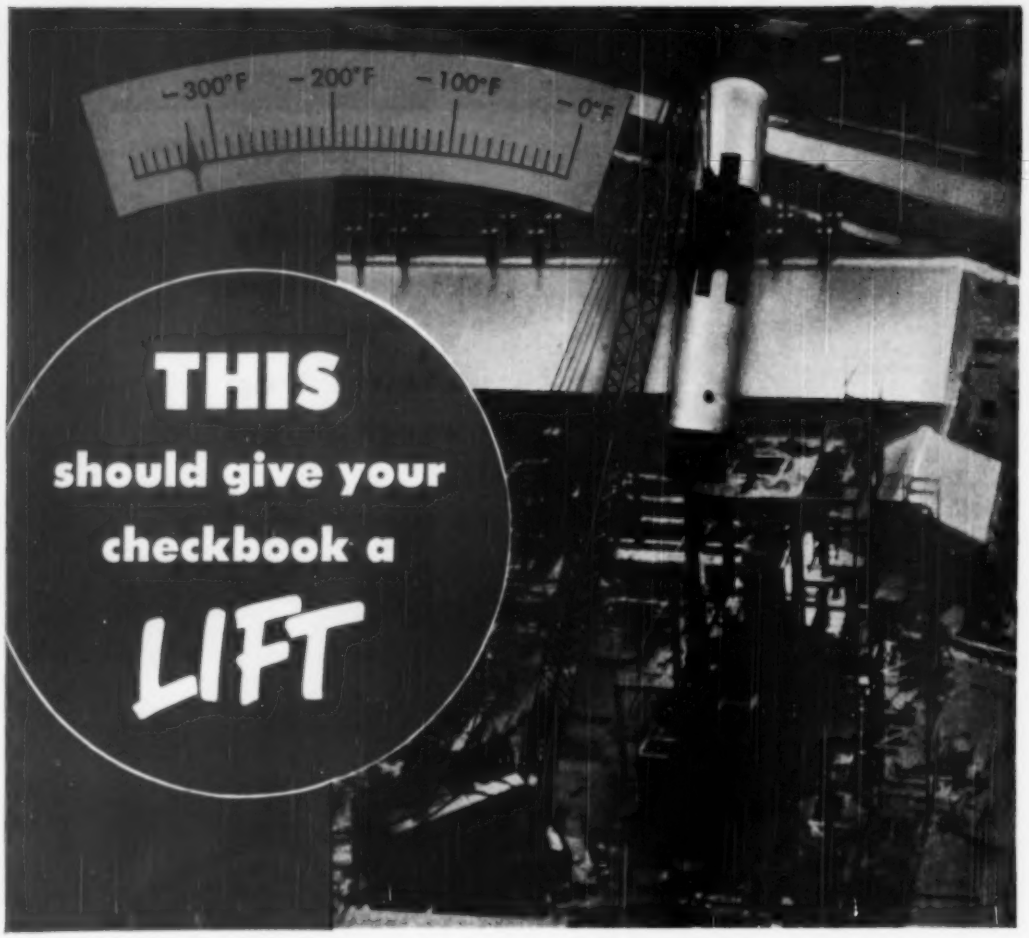

Ordinarily it would take two cranes to lift this oxygen plant bubble-cap tower into position. But this is no ordinary tower. Made of Alcoa Aluminum, it weighs half as much as towers of heavy metals . . . handles far easier in fabrication, shipment and installation.

Also Alcoa Aluminum gets stronger and tougher as temperatures drop. It costs 25 to 50% less than other materials suitable for sub-zero processing.

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Please send more information on aluminum's properties and applications for sub-zero process equipment.

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ALCOA

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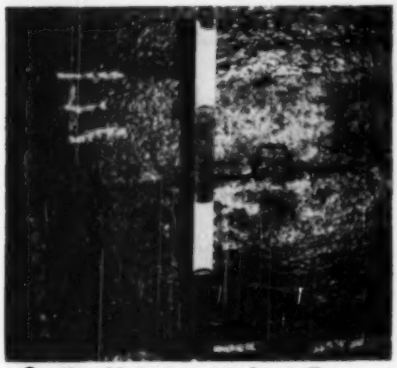
CHLORINATION BY WALLACE & TIERNAN

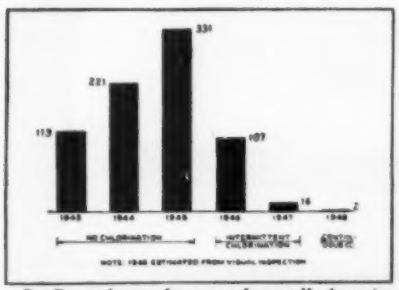
CONTROLS MARINE FOULING AT GENERATING STATION

LOOK AT THESE RESULTS

1. Before chlorination — mussels cover wall to depth of 3".



2. After chlorination — note bare wall.



3. Tons of mussels removed annually from intake tunnel of generating station.

It all began when a New England generating station sent down a diver for a routine inspection of the large, concrete, circulating-water, intake tunnel located approximately 13 feet below the harbor's surface. The diver discovered this intake was lined with unusually heavy growths of common mussel (Mytilus), sea moss (Tubularia), and sea anemone (Metridia).

These were expensive visitors. First, mussel accumulation created poor vacuum as the mussels lodged in condenser tubes and aggravated slime and silt formation. Then, as the mass increased in quantity, it became necessary to clean the intake tunnel every year to remove up to a maximum of 331 tons of mussels — a time consuming process that cost thousands of dollars in labor and equipment outage.

To combat these conditions a long and thorough study was made of marine fouling. As a result it was decided to use intermittent chlorination applied by Wallace & Tiernan Chlorinators. First to fall under this attack were the sea moss and the sea anemone. The tougher mussels however, still remained as numerous as ever.

In an all out effort to get rid of these trouble makers, continuous chlorination at heavier residuals was started. This treatment turned the trick and the mussels were reduced to such a low level that yearly cleaning has not been required.

These results saved the New England company thousands of dollars annually by eliminating intake tunnel cleaning, reducing condenser outages, and producing a higher vacuum with a resultant saving in fuel.

Perhaps your problem is one of slime or fouling due to some other marine organism. In any event, if biological fouling is costing you money through lowered cooling water efficiency it's a safe bet that chlorination can help.

See your nearest Wallace & Tiernan Representative now for all the details.

CD-34

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CHLORINE AND CHEMICAL CONTROL EQUIPMENT

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Worried About pH Control?

New Immersion Electrode Assembly uses no sampling line.

New lightweight Flow Electrode Assembly for sampling line measurements.

Two families of controllers for pH applications.

"Controllability Analysis" form for engineering data.

With brand-new developments in pH equipment, plus 26 years experience in pH instrumentation, L&N now has new answers to several important types of industrial pH problems. Furthermore, a unique, time-saving "Controllability Analysis" service quickly and accurately points to the control system which will solve the specific problem.

New developments in equipment cover both the electrodes which sense changes in the pH, and the housings or assemblies which hold the electrodes.

Entirely waterproof construction is featured in the new electrodes. It makes them ideal for humid or wet locations, since they are fully immune to electrical leakage as well as to penetration by process liquids.

One of the new assemblies is an immersion-type unit, to operate in tanks, reactors, etc.; it can even be totally submerged if necessary. It also operates in many places which formerly required a flow-type unit; in such cases it eliminates both the installation and the maintenance of sampling line, pump and accessories. It is made of light, corrosion-resistant plastic.

The other new electrode assembly features convenience and stability where a flow-type unit must be used. Made of plastic, it is light, small, easy to install and thoroughly dependable. Where plastic might not suit, we of course continue to supply assemblies of cast iron and/or Pyrex brand glass.

Two families of recording and controlling instruments are now available: the familiar, accurate and reliable Micromax and the newer but equally dependable Speedomax continuous-balance instrument. Both are available with either electrical or air actuated control systems.

For application engineering simply fill in one of our "Controllability Analysis" forms. Our engineers can then tell how closely pH can be held with either present or proposed plant layout. Let's get together on that pH problem! You will not be obligated; simply write to Leeds & Northrup Co., 4923 Stenton Avenue, Philadelphia 44, Pennsylvania.

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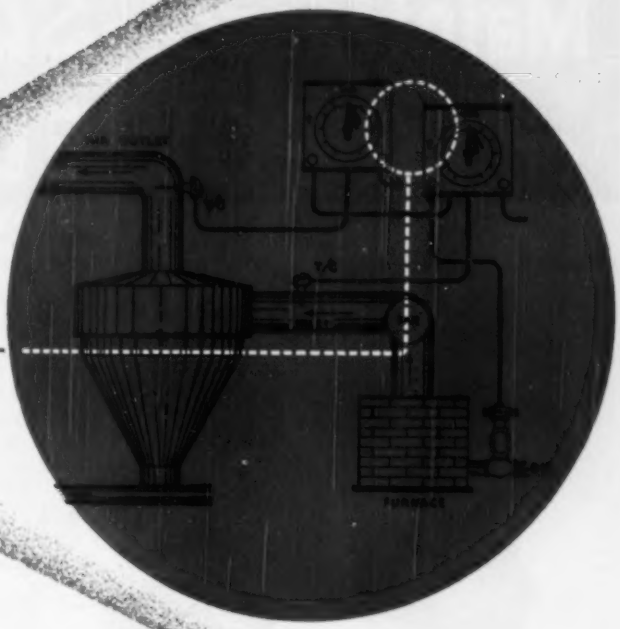
with the Brown Remote Indexet



THE Brown Remote Indexet affords a positive way to a new high in sensitivity and accuracy of control action . . . meeting the unusual demands of many types of advanced process equipment.

Typical is its application to the control of the drying chamber in a spray drying unit for distillers solubles. Here, the outlet temperature controller sets the index of the secondary instrument, whose thermocouple is inserted in the inlet air duct. The secondary instrument actuates a control valve on the oil flow to the furnace.

With the use of these controllers interconnected by means of the Remote Indexet, the inlet temperature controller compensates for the undesirable process characteristics of heat transfer in the furnace while the outlet temperature controller compensates for the process characteristics of the drying chamber.

The result is super-sensitive cascade control, with rapid response to variations in operating conditions.

For full particulars on the use of the Remote Indexet for your particular process, call in your local Honeywell engineer . . . he is as near as your phone.

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FOR THE PETROLEUM INDUSTRY

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

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When you buy a valve, ask yourself these two questions. First, will it operate satisfactorily in the service in which it is to be used? Second, and of most importance, how much *maintenance* will it require? Because, every time maintenance becomes necessary, there's a two-fold cost. One, the cost of labor—and possibly parts—to put it back in working order. Two, the loss of production farther down the line.

And, because Powell Engineers *always* have this in mind, every valve in the *complete* Powell Line* is designed and made to avoid, as far as possible, "DOWN-TIME" for maintenance.

That's why, through the years, Powell Valves have been noted for long, trouble-free performance—even under the most exacting service conditions.

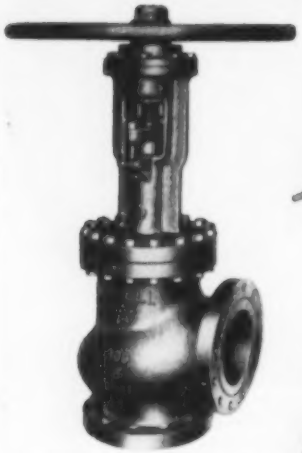

Fig. 3033—Class 300-pound Cast Alloy Steel Angle Valve with flanged ends, outside screw rising stem and bolted flanged yoke. The streamlined areas through the body assure maximum flow with minimum pressure drop. Built to handle temperatures up to 1400 F.

Fig. 6079—Motor Operated Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Classes 150, 300, and 400-pound valves can be furnished. Also available with gears.

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge.

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

*** The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.**

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DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

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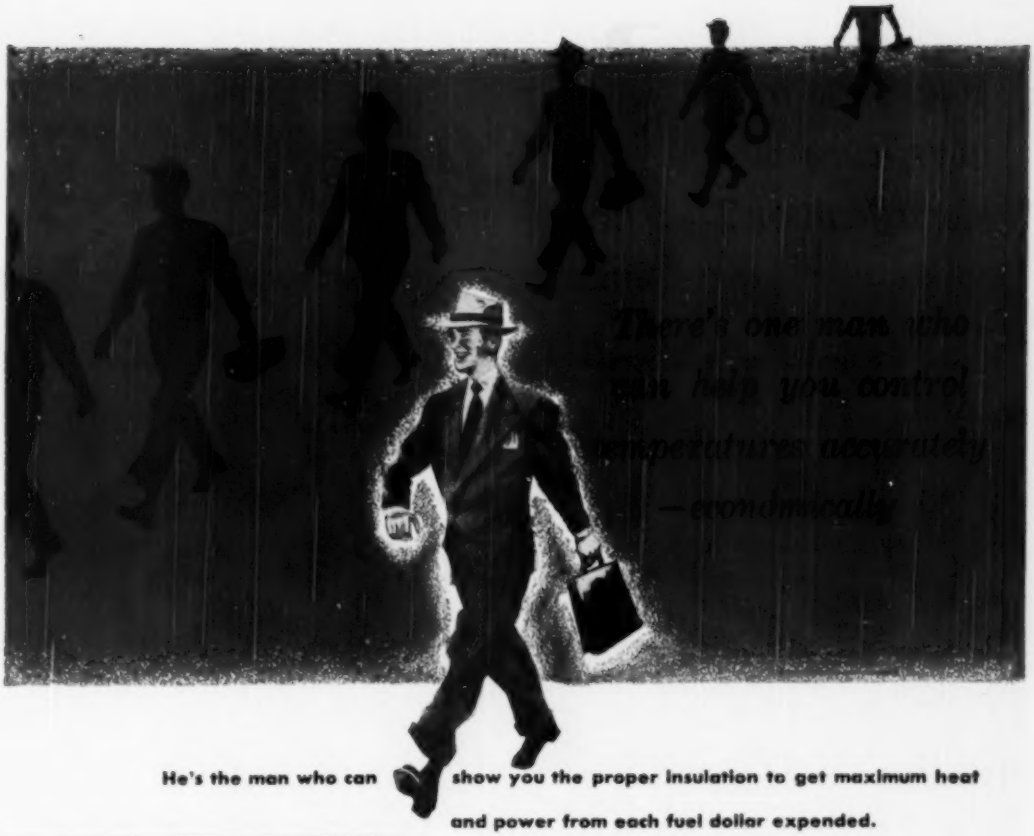

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Here's one insulation that will save you money

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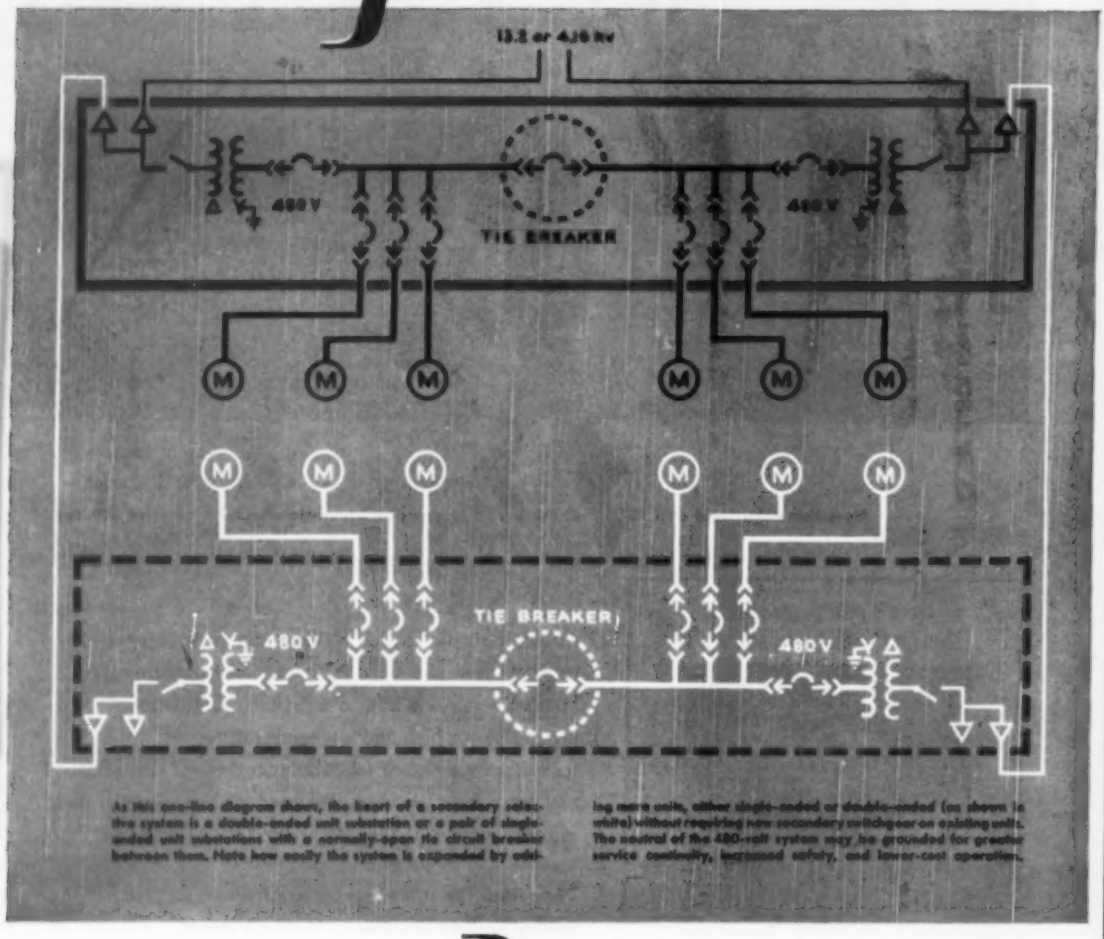
Since 1843

What's the trend in refinery electrification?

secondary



As this one-line diagram shows, the heart of a secondary selective system is a double-ended unit substation or a pair of single-ended unit substations with a normally-open tie circuit breaker between them. Note how easily the system is expanded by adding more units, either single-ended or double-ended (as shown in white) without requiring new secondary switchgear on existing units. The neutral of the 480-volt system may be grounded for greater service continuity, increased safety, and lower-cost operation.

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to assist you in co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

selective distribution systems

WITH UNIT SUBSTATIONS

—to protect continuity of service at minimum cost

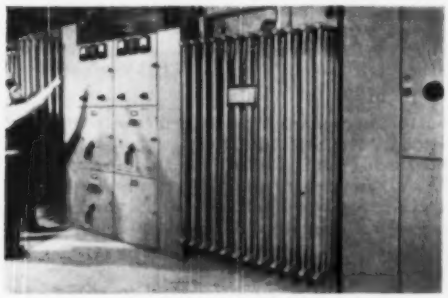
What's behind the growing refinery practice of distributing power through secondary selective systems? Primarily it's recognition of the fact that for most plants it provides a simple, low-cost way to safeguard service continuity for operations requiring uninterrupted production.

This method utilizes a normally-open tie circuit breaker between the secondaries of two transformers in a double-ended unit substation. The tie provides an alternate source of power for secondary circuits if either transformer becomes de-energized by a fault in the primary circuit. In effect, it enables one "partner" when necessary to carry the essential load.

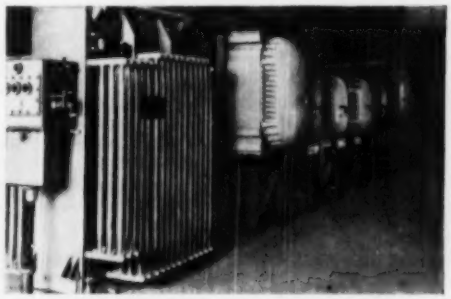
Simplicity is another advantage of this system. Operating personnel need no special training to operate and maintain the equipment contained in a double-ended unit substation—chiefly transformers and manually-operated drawout air circuit breakers.

Moreover, expansion is easy and economical. Single-ended or double-ended substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GET-1438, "Secondary Networks for Industrial Plants." Send for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

TO HELP CUT YOUR POWER DISTRIBUTION COSTS . . . Don't miss seeing the "More Power to America" full color and sound slide-film "Modern Industrial Power Distribution." It's packed with helpful, cost-cutting ideas you can use. Ask your G-E representative to arrange a showing for your organization. .

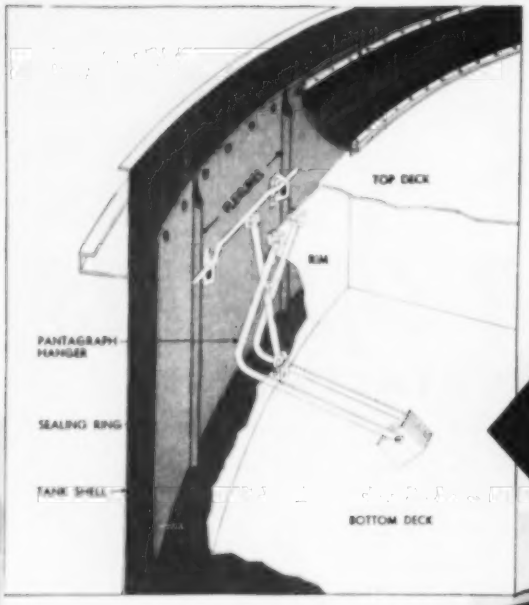


G-E double-ended load-center unit substations for non-hazardous areas are compact, factory-assembled "packages." Shipped ready to install, they are furnished in flexible combinations of incoming-line and secondary-circuit arrangements with transformers from 100 to 2000 kva.

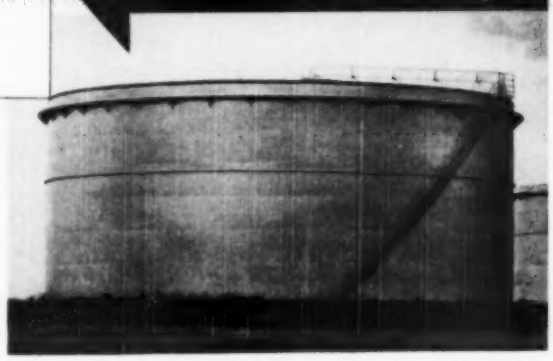


For semi-hazardous areas, G-E double-ended load-center unit substations have easily removable air circuit breakers, each in Class I, Group D enclosures, plus primary power circuit breaker, a standard Pyranol (R) transformer section, and a secondary bus enclosure.

GENERAL ELECTRIC



THREE REASONS WHY vapors don't get by the HORTON* Seal



Above: 125-ft. diam. by 56-ft. tank equipped with a Horton Double-Deck Floating Roof at the Texas Pipe Line Company's Midland, Texas, station. It is used to store sour crude oil.

THE improved Horton Seal closes the space between the deck of a Horton Floating Roof and the shell of the tank on which the roof is installed. It is one of the best devices ever developed for this service because of the combined effectiveness of the following parts:

1. ***continuous sealing ring***—The Horton Sealing Ring provides better protection against vapor losses because it forms a close contact with the inside of the tank. Vertical flexures every 22 inches allow the ring to expand and contract enough to conform to the inside of the tank shell. These flexures also serve as stiffeners to distribute the radial pressure exerted by the pantagraph hangers over the entire height of the sealing ring.

2. ***pantagraph hangers***—These hangers support the sealing ring and apply an outward pressure at each flexure. They hold the sealing ring surely but gently against the tank shell so that it maintains a long sliding contact with the inside of the shell as the roof moves up and down in the tank. The pressure exerted by the hangers is just strong enough to insure good contact—but does not cause excessive wear of the sealing ring.

3. ***continuous fabric***—This gastight, weatherproof flexible fabric closes the space between the top of the sealing ring and the deck of the floating roof. Making the space in the seal gastight is an effective, economical way of keeping evaporation losses low from a relatively small area. The fabric is not affected by contact with petroleum liquids and vapors.

The Horton Seal is now standard construction on the three types of Horton Floating Roofs . . . the Double-Deck Floating Roof, the Pontoon Floating Roof, and the Pan Floating Roof. Improvements like this seal are typical of the benefits you get from dealing with a company that has been building floating roofs for 27 years. Write our nearest office for complete details.

*Trademark registered at U. S. Patent Office

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There's no PARTIAL safety

Where safety valves are involved, "safety" must be absolute!

In no other valve can you find the extra safeguards incorporated in CONSOLIDATED Safety Relief Valves. The fixed capacity is built in —not dependent on the position of multiple and adjustable blow-down rings.

One single adjustment controls blow-down without disturbing lift or secondary annular orifice areas.

Under discharge piping stresses, the outside bevel seat and floating guide prevent leakage.

CONSOLIDATED Safety Relief Valves are so simple in design there are 25% fewer parts than in ordinary safety relief valves. Obviously maintenance costs are reduced and utmost economy is achieved.

Specifying "CONSOLIDATED" is wiser than knowing what was to blame for the accident that needn't happen. Be *surely* safe.

CONSOLIDATED SAFETY RELIEF VALVES

A Product of

MANNING, MAXWELL & MOORE, INC.
TULSA, OKLAHOMA

Makers of 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges, Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists, and other lifting specialties.

LOW COST

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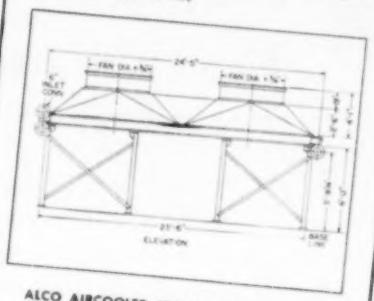
Precision engineering—standardized parts—volume production—plus correct engineering application with proper safety factors—these are the features that give you lifetime operating economies with Alco **Aircoolers** and make them the best buy for your heat exchange dollar.

Proved by performance on some of the largest air-cooled installations in the world, these dependable units can help with your problem, particularly if you have a poor or inadequate water supply. With Alco **Aircoolers** such troubles as scale, costly water treatments and other cooling headaches are eliminated.

For more details send for the free Alco **Aircooler** Catalog, or see your nearest Alco Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.

ONE AIRCOOLER FROM THE ALCO LINE

ALCO Aircoolers like these shown in a large gasoline plant are used in hundreds of installations for cooling jacket-water, gas, engine lube-oils, vapors, etc.



ALCO AIRCOOLER, UNI-BUNDLE MODEL T-1
CONDENSED SPECIFICATIONS

No. of tubes per row—30 29 (staggered pitch).

No. of bundles per unit—One.

Fans—Two or three—5 ft. or 6 ft.

Drive—Direct Electric Motor (V-belt or Gear Drive can be furnished on request).

Face Area—135 sq. ft.

ONLY ALCO HAS THE BIG 5

1 LOW COST
2 Flexible Design
3 Efficient Performance
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5 Quick Installation

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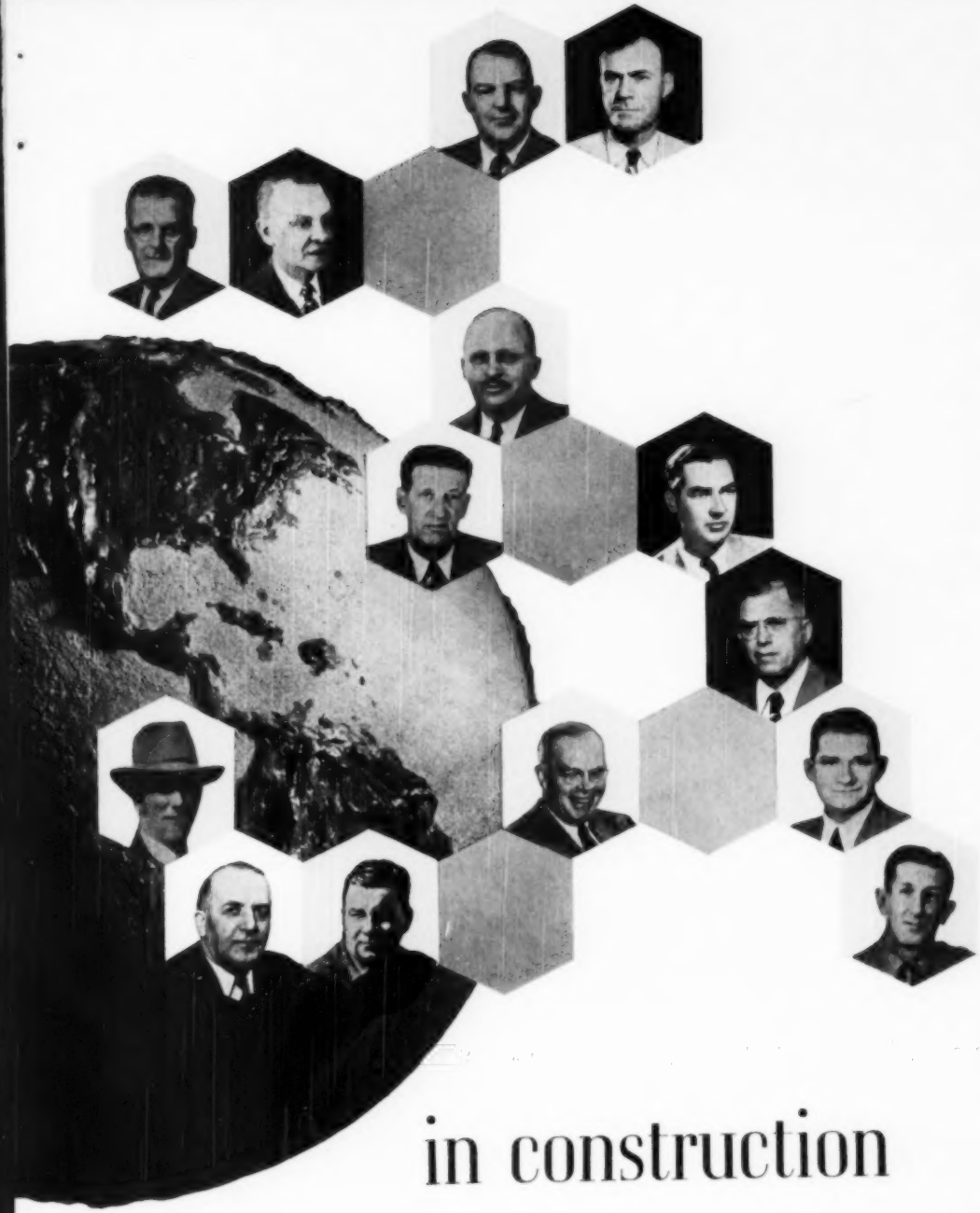
In step with tomorrow—ALCO AIRCOOLERS. **Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe**



in construction

these men are at home 'round the world

turn page . . .

The Lummus construction superintendent and field engineer averages a twelve-year record of refinery building, literally—"everywhere under the sun." In addition, he has seen service at chemical plants and other heavy construction both in this country and abroad.

In a period of rapid progress, he has contributed to new techniques: the preassembly of pipe and equipment before erection, the raising of heavy vessels to greater heights and the providing of means to facilitate future maintenance and "turn around." Refinements in the scheduling of the erecting sequence are an outgrowth of his experience.

Behind Lummus' "ahead of time" deliveries stands the Construction Man. Because he has learned to *anticipate* the problems of remote location, emergencies seldom arise. But the records show that his decisions, made on-the-spot to meet the unexpected, reveal sound judgement and a steady hand. The low labor turnover, reflecting the high morale of his crews, both American and native, is evidence of his human as well as his technical understanding.

During the war he constructed, in record-breaking time, ordnance plants, high octane gasoline plants and plants that produced the raw materials for synthetic rubber. Today, the Lummus Construction Man is combining *time savings* with *dollar savings* in new projects throughout the world.

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This new eighty page book describes the latest process developments in petroleum refining.

Detailed descriptions and flow charts of more than thirty refinery processes are featured. Photographic techniques are employed to assist you to visualize units. Send for your copy—today.

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Bubble caps made of the one alloy that best meets the coking and corrosion problems in your fractionating towers would, obviously, mean fewer cleanouts and less "down" time. The Pressed Steel Co. enables you to make such a selection, because we fabricate from the complete list of alloys. Records of PSC installations show that the resulting increase of "on-stream" hours often results in substantial long-run economies. In addition to being "alloy-right", PSC bubble caps benefit from our almost quarter-century of experience in fabricating welded-alloy refinery equipment and tubing.

Over 200 STANDARD STYLES of Caps and Risers, without Die Cost

With the dies on hand, we not only make prompt delivery but also save many customers the cost of dies. Special caps promptly designed. Send blue prints

New LE JONS ASSEMBLY *Saves 7 Ways*

Offering unprecedented simplicity, this new method of bubble cap assembly features: Faster assembly--no bolts or nuts, just hammer in wedges. Automatic alignment of caps. Tighter assembly. Stronger trays. Eliminates costly flaring or welding of risers. Less maintenance. Ease of cleanout or replacement.

Send for

BUBBLE CAP BULLETIN 21

The largest compilation of engineering data on bubble caps in printed form. Also drawings for use in determining methods of tray assembly. BULLETIN 31 describes LeJons assembly.

PSC EQUIPMENT IS "ALLOY RIGHT"

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You get truly cushioned closing with these tilting-disc check valves. There's no slamming. Instead, the disc rides smoothly on the flow, opens easily, closes quickly and quietly. Because of this effortless action, power costs are lower (when used on pump discharge lines) . . . maintenance costs are lower . . . operating expenses are saved in a dozen ways.

Available in either iron or steel. Write for bulletin with complete information.

The Chapman Valve Mfg. Co.
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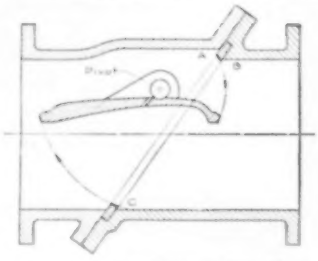

Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

ESSO STANDARD OIL COMPANY

Uses

A. P. GREEN SK-7 KS-4

for Regenerator Lining

The regenerator of this huge Esso Standard Oil Company cat-cracking unit is lined with A. P. Green SK-7 and KS-4. It has been giving excellent service.

Application of SK-7 completed. Steel mesh attached to studs preparatory to shooting KAST-SET KS-4.

Interior of Catalytic Regenerator showing the completed lining with the KAST-SET KS-4 applied over the CASTABLE No. 20 SK-7.

CHECK THESE ADVANTAGES OF SK-7 and KS-4

1. Cuts installation time and labor costs
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A. P. Green REFRACTORY PRODUCTS

Esso Standard Oil Company, Linden, New Jersey, is one of the leaders in the petroleum industry who use A. P. Green SK-7 and KS-4 for lining regenerators in cat-cracking units. The contour of cat-cracker regenerators lends itself to the use of these specially designed and engineered gun-applicable refractory castables.

CASTABLE No. 20 SK-7 is a lightweight insulating castable recommended for a service temperature of 1800° F. KAST-SET KS-4 is a castable refractory with a top service temperature of 2750° F. Both were designed specifically for gun application in the Petro-Chemical industry.

For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company — or call your local A. P. Green Distributor.

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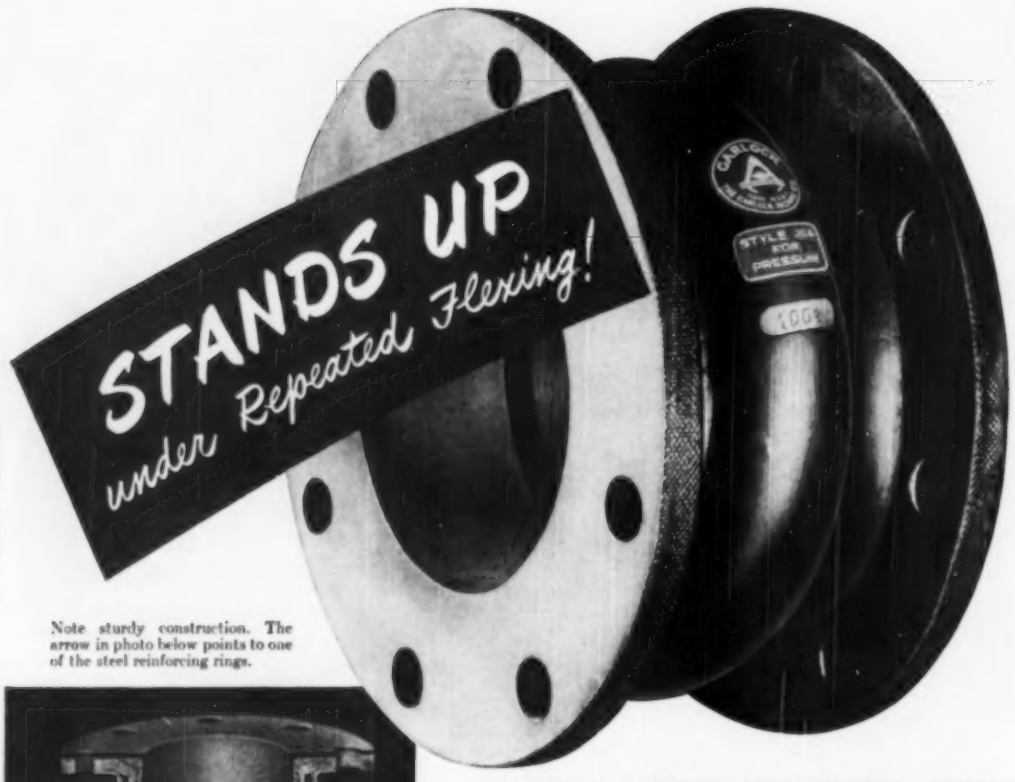
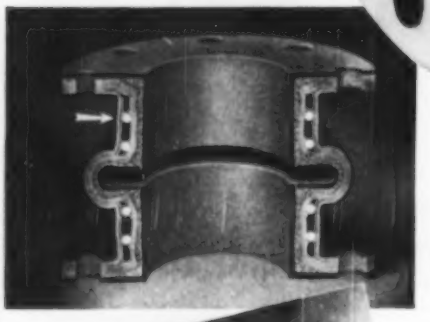


Note sturdy construction. The arrow in photo below points to one of the steel reinforcing rings.



GARLOCK RUBBER EXPANSION JOINTS

resist cracking and corrosion— and do not take a permanent set

GARLOCK RUBBER EXPANSION JOINTS hold up under repeated flexing caused by expansion, contraction and vibration of the pipe line, because they are constructed of high grade rubber which is combined with plies of sturdy cotton duck and reinforced with steel wire or rings. Where oil resistance is necessary, neoprene joints are available.

For all pipe sizes from 2" to 72", including tapered joints. Specify No. 204 for *Pressure;* 205 for *Vacuum;* 206 for *Pressure and Vacuum.* Write for descriptive folder.

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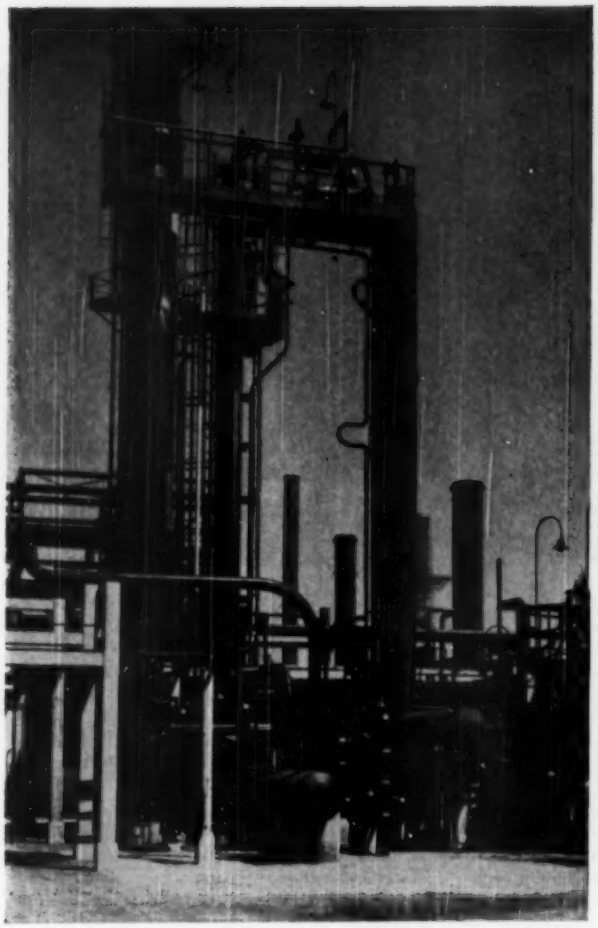

Double-duty **Girbotol** plant purifies both **Liquid** and **Gaseous** hydrocarbons

THE GIRDLER GIRBOTOL PROCESS, long famous for purifying gaseous hydrocarbon mixtures, is now recognized everywhere as the most effective method of purifying certain liquid hydrocarbons.

The modern GIRBOTOL plant shown above *does both.*

The liquid phase section of this plant is designed to handle 800 barrels per day of liquid hydrocarbons having a hydrogen sulphide content of 1000 grains per 100 equivalent SCF. The purified outlet hydrocarbon contains not more than 5 grains of hydrogen sulphide per 100 equivalent SCF.

The gas phase section is designed to purify 900,000 SCF per day of refinery gas having 4400 grains of hydrogen sulphide per 100 SCF and 1.0% of carbon dioxide. The outlet hydrogen sulphide content is not more than 5 grains per 100 SCF and practically zero carbon dioxide.

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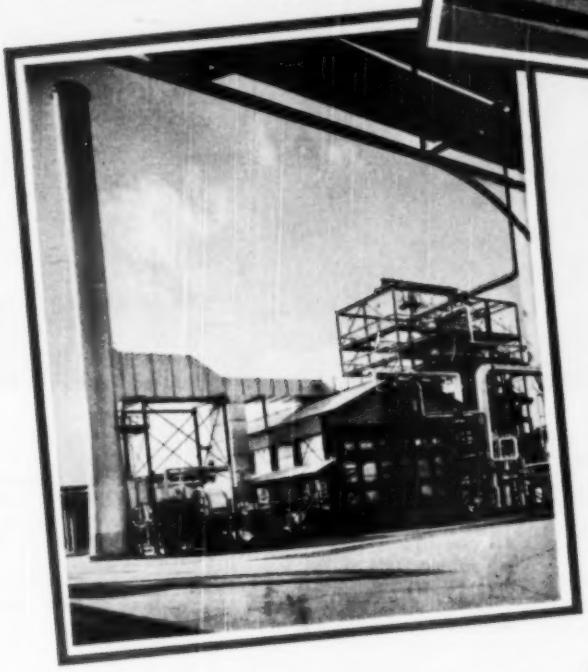
Views of Alcorn Combustion Co. crude heater for Continental Oil Co., Ponca City, Oklahoma.



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NO EXPENSIVE ALLOYS
These high-insulating brick can be supported by ordinary carbon steel hangers . . . don't require expensive, heat-resisting alloys.

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B&W Insulating Firebrick withstand severe service for years . . . keep maintenance costs to a minimum.

See how these economies add up in your plant. Talk to your B&W Representative. He'll gladly give you facts and figures on money-saving B&W Refractories.

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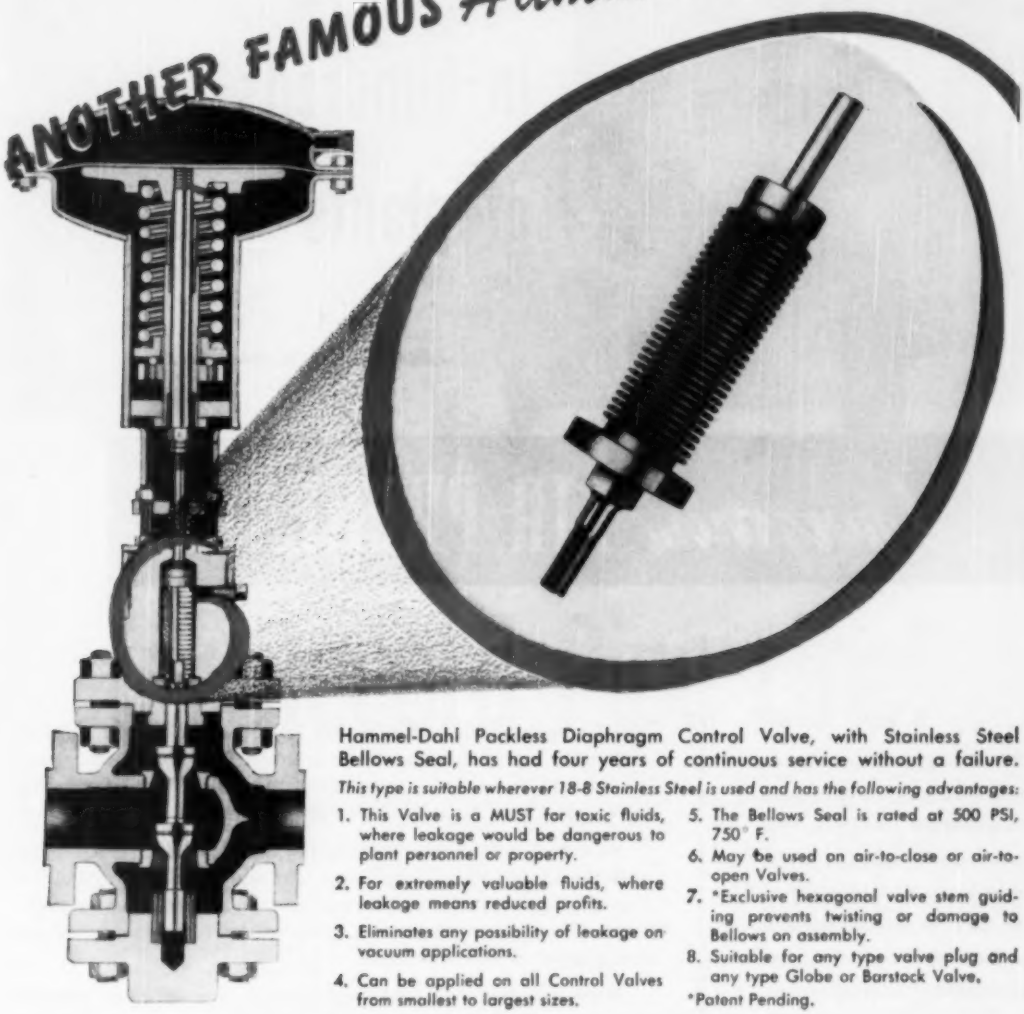
ENGINEERED DESIGN BY **HAMMEL-DAHL**

ANOTHER FAMOUS *Hammel-Dahl* FIRST



Hammel-Dahl Packless Diaphragm Control Valve, with Stainless Steel Bellows Seal, has had four years of continuous service without a failure.

This type is suitable wherever 18-8 Stainless Steel is used and has the following advantages:

1. This Valve is a MUST for toxic fluids, where leakage would be dangerous to plant personnel or property.
2. For extremely valuable fluids, where leakage means reduced profits.
3. Eliminates any possibility of leakage on vacuum applications.
4. Can be applied on all Control Valves from smallest to largest sizes.
5. The Bellows Seal is rated at 500 PSI, 750° F.
6. May be used on air-to-close or air-to-open Valves.
7. *Exclusive hexagonal valve stem guiding prevents twisting or damage to Bellows on assembly.
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*Patent Pending.

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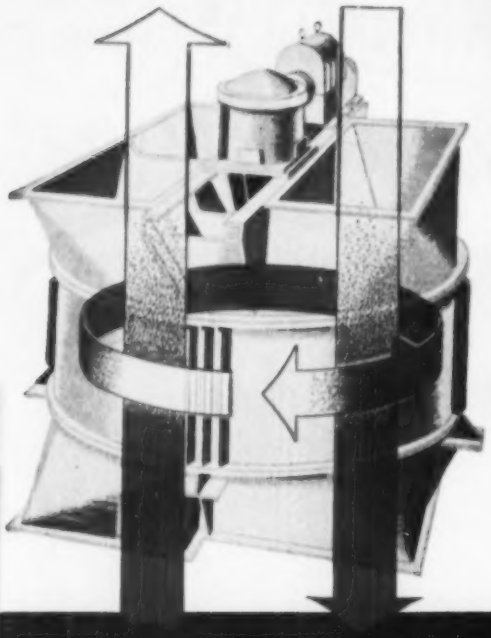

this preheater is cutting fuel costs in hundreds of plants

the *Ljungstrom* AIR PREHEATER

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

The Ljungstrom air preheater has proved its value in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

Your fuel costs will be lower too, when your boiler is equipped with the Ljungstrom air preheater. The regenerative design of the Ljungstrom permits reliable operation at low exit gas temperatures. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

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THE AIR PREHEATER CORPORATION

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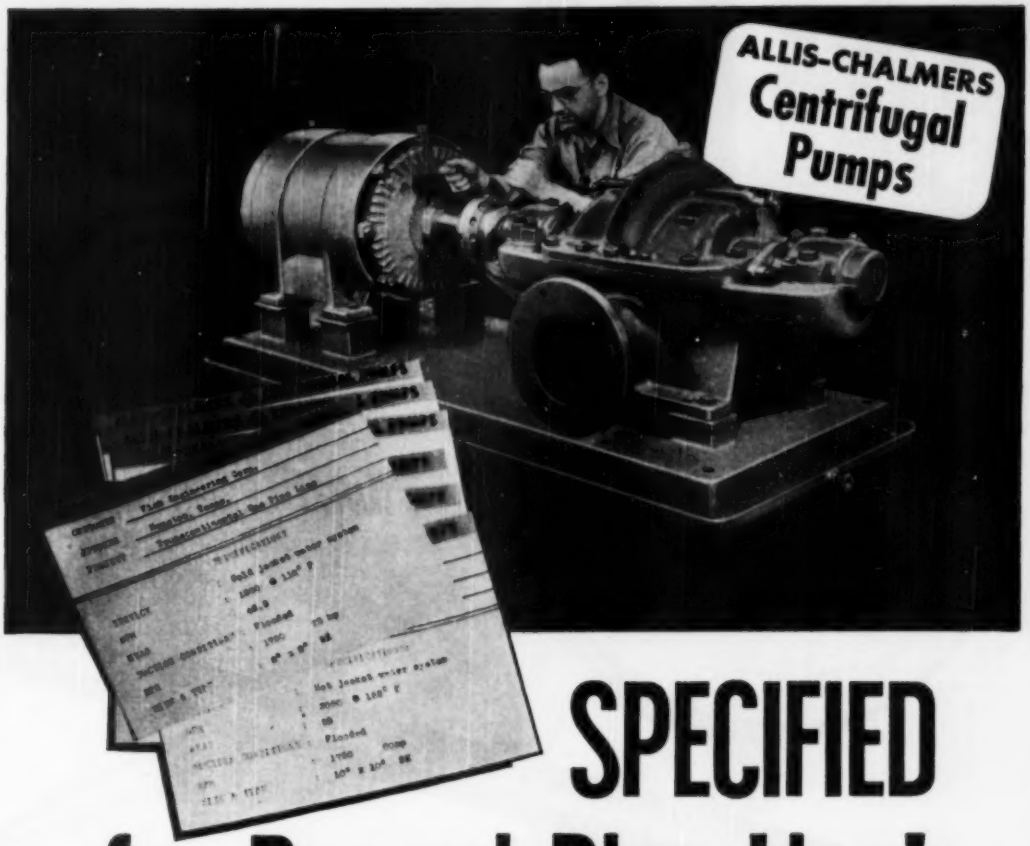

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Throughout the petroleum industry the demand for high efficiency, low maintenance pumps has steadily increased. To serve this need, Allis-Chalmers builds pumping units engineered for specific applications. Maintenance records over a period of years prove this policy saves money and trouble for the purchaser.

You get one guarantee for the operation and efficiency of the complete unit.

Allis-Chalmers supplies pumps with capacities up to 170,000 gpm and pressures up to 2500 lbs. Special pumps are built for tough applications such as highly abrasive and corrosive liquids.

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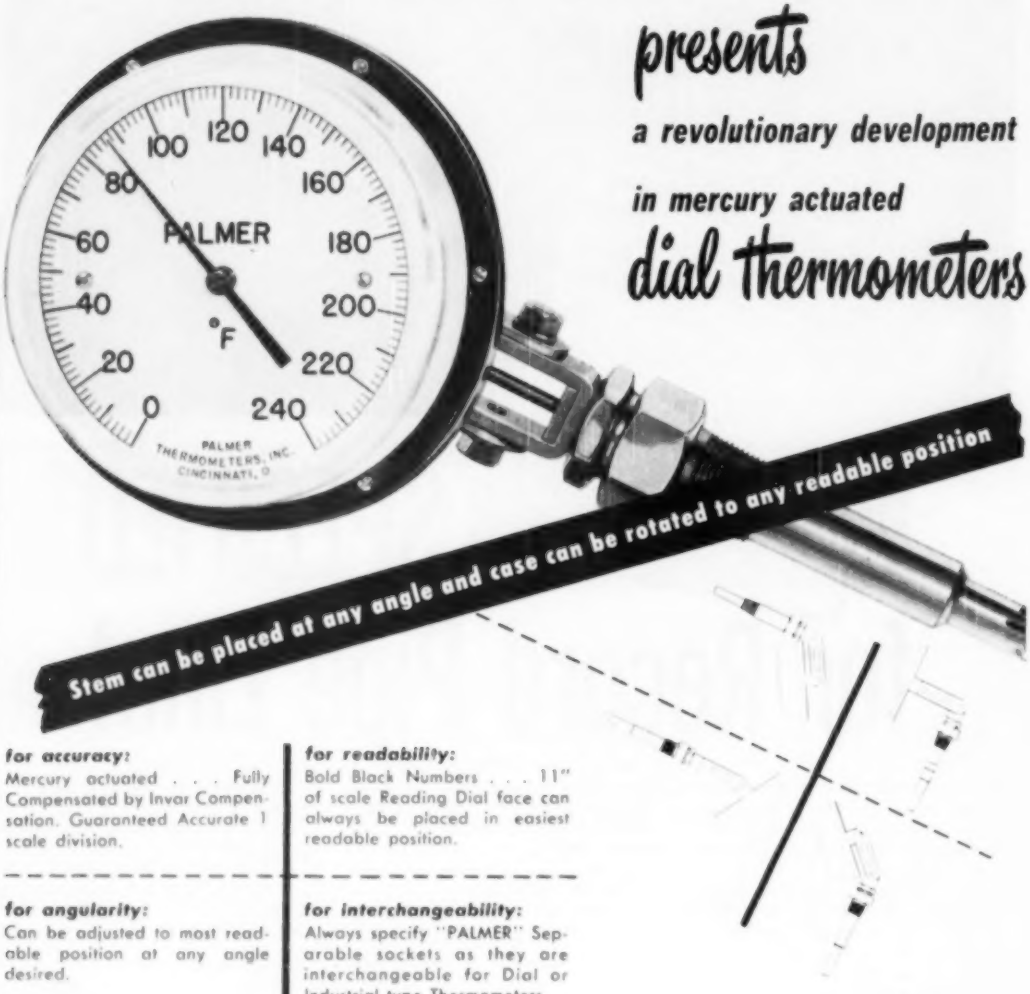

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Can be adjusted to most readable position at any angle desired.

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Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

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For details on the New Palmer Dial Thermometer, please write for Palmer Bulletin 50-128.

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Made from Alloy Steel—from the furnaces of Republic, world's leading alloy steel producer.

It's DOWN with

Maintenance!

. . . and UP with PRODUCTIVITY with this stud!

● Where the operating conditions are tough, this Republic Upson Alloy Steel Stud is tough, too. It puts up stubborn resistance to blistering heat and stamina-testing pressures. It is also highly resistant to corrosion.

This adds up to minimum maintenance—minimum down-time—which together drive your productivity curve steeply upward. In addition, because of the precision in their making, they turn off as freely as they go on. Time is thus saved when it is necessary to remove them.

Increase productivity *two* ways—(1) *Replace* every case of stud failure with rugged Republic Upson Alloy Steel Studs . . . and (2) On *new equipment* specify these studs and assure low maintenance from the start!

REPUBLIC *Upson Quality* **ALLOY STEEL STUDS**

REPUBLIC STEEL

REPUBLIC STEEL CORPORATION
Bolt & Nut Division • CLEVELAND 13, OHIO
Export Dept.: Chrysler Building, New York 17, N.Y.

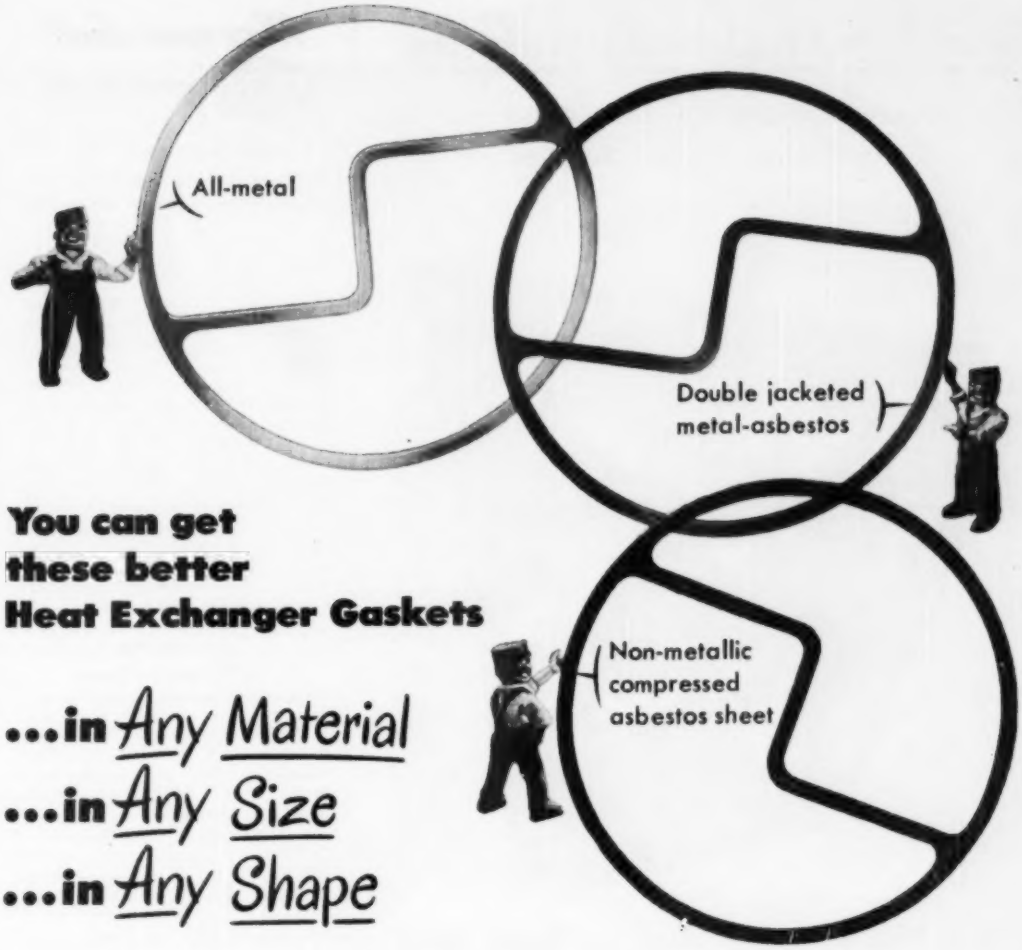
Other Republic Products Include Machine, Tank and Carriage Bolts—Lag Screws, Cap Screws and Rivets

OVER 400,000 BARRELS DAILY THROUGHPUT LICENSED BY PERCO*

Perco Processes, such as Copper Sweetening and Cycloversion*, are proving their daily effectiveness in all sizes of refineries and gasoline plants. Basic Perco designs are simple. Construction costs are attractively low. High operating efficiencies are achieved and maintained with remarkably small manpower and instrumentation control. Write us for information on how a Perco installation will integrate with your facilities to help you realize more profit from your daily throughput.

*A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA



You can get these better Heat Exchanger Gaskets

...in Any Material
...in Any Size
...in Any Shape

YES—YOU CAN HAVE Goetze heat exchanger gaskets designed to your exact requirements... *tailor-made* from the material you want... *precision-made* to the size and shape you need.

Each of the three gaskets shown above, for example, is made of a different material: all-metal, metal-asbestos, and compressed asbestos sheet. Yet each has the common denominator of meticulous care in every detail of construction that is the birthmark of every custom-crafted Goetze gasket.

Take the popular double-jacketed metal-asbestos type as an example. There are no wrinkles on the inside corners... no cracks on the outside corners; lap widths are ample; rib widths are uniform. Above all, like every Goetze heat exchanger gasket, it is accurately made to close tolerances... can be depended on to fit and seal perfectly... will stay on the job indefinitely without leaks or blowouts.

Because Goetze has been making gaskets for industry's most complex jobs over the past sixty years... we can solve your problem with a better heat exchanger gasket that will save you money in the long run. For complete details about these and other types of Goetze gaskets, write for your copy of the new Goetze Gasket Catalog. Address Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville Goetze GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE.

For Top Flight Gas Welding

Choose from AIRCO'S complete line of Oxyacetylene Welding Supplies

Time Proved . . . Job Tested . . . Money Saving

Available from Local Stocks

That's right! Whether you use a popular Airco gas welding rod, flux, or brazing alloy for production or maintenance operations . . . you're certain of top-notch work—ask any one of the thousands of welders who swear by these Airco oxyacetylene welding supplies.

This well-recognized reputation for top performance didn't just happen—more than thirty years' experience and development have gone into the manufacture of these outstanding gas welding supplies . . . know-how that produces high quality, reasonably-priced items that guarantee a job done faster, done better, done easier and done at less net cost.

For further information about Airco's oxyacetylene welding supplies which includes a complete line of rods, fluxes and brazing alloys, write your nearest Airco Office or Authorized Dealer for a free copy of Catalog 12.

More news about AIRCO products

AIRCO No. 1 ALLOY STEEL

A Smooth-Flowing, High Ductile Rod Insuring Good Control of Molten Pool

This rod (AWS Classification GA60) is ideal for welding low carbon and low alloy steels, including pipe of grades A and B analysis. Outstanding among its many important features is the high ductility in the "as welded" condition. Because of its mechanical properties, this rod is desirable when undertaking qualification tests like those included in The American Standards Association Code for Pressure Piping. It is smooth flowing, insuring good control of the molten pool, and, in addition, will withstand considerable heating without burning.

PHOS COPPER

A High Standard Copper And Phosphorous Brazing Alloy

It is self-fluxing when used on copper-to-copper joints but requires a good low melting point flux when brazing brass, bronze or other alloys. It is completely fluid at approximately 1382°F. at which temperature best results are secured and is used in the manufacture of electrical, refrigeration and air conditioning equipment. Available in rod and strip form.

AIRCO MARVEL BRAZING FLUX

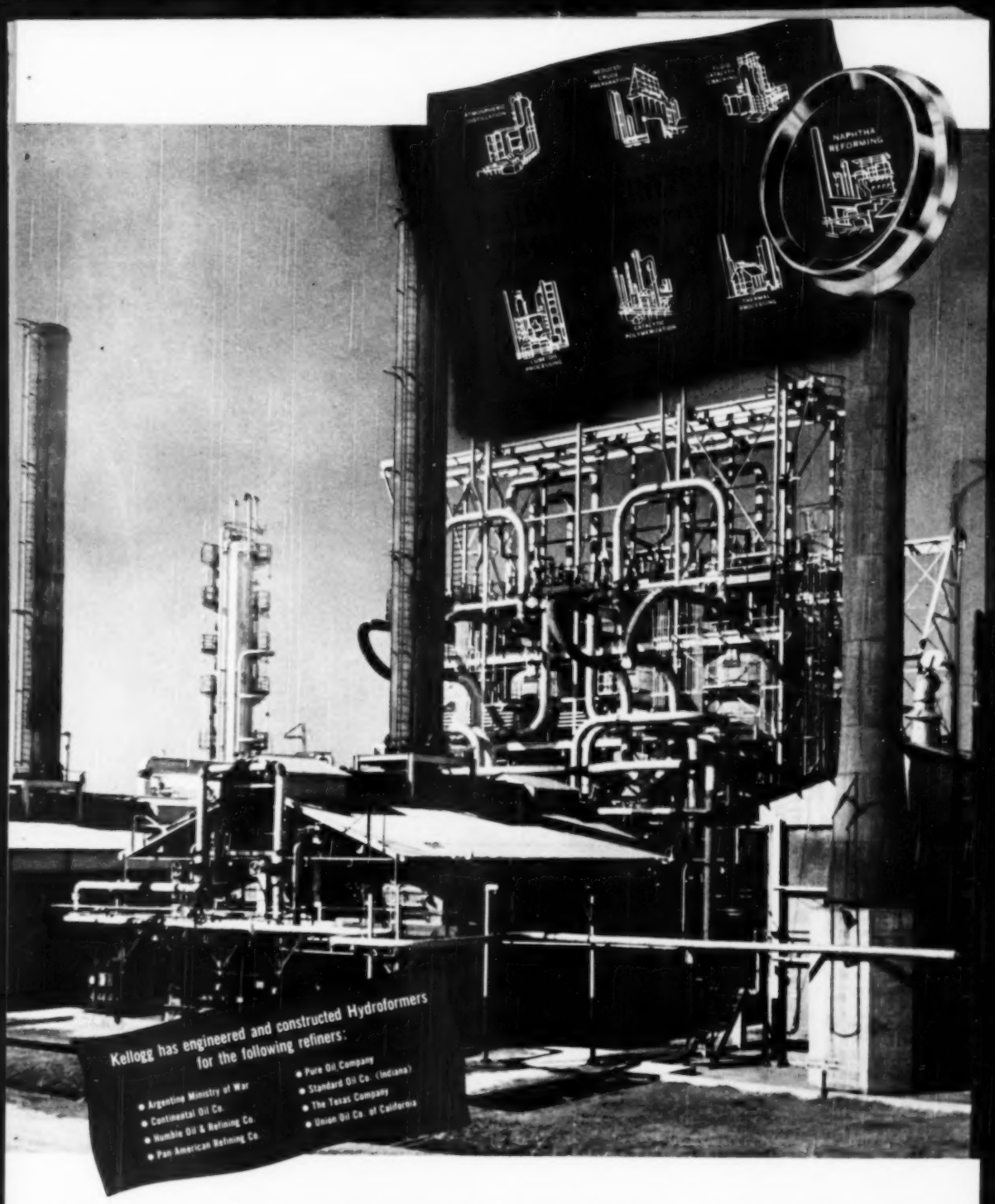
A High Quality Flux That Remains Molten And Viscous Over A Wide Temperature Range

It is a uniformly high-quality flux for use in braze welding cast iron, malleable iron, copper and steel and for welding brass, bronze and copper. Marvel Flux remains molten and viscous over a wide temperature range. Its use protects the weld metal from oxidation and effectively reduces or removes oxides and other foreign matter. Marvel Flux is a general purpose flux for the welding shop.

AIR REDUCTION MAGNOLIA COMPANY

A Division of Air Reduction Company, Incorporated

Houston • Beaumont • Corpus Christi • Wichita Falls
El Paso • Fort Worth • San Antonio • Dallas


NAPHTHA REFORMING
Kellogg has engineered and constructed Hydroformers for the following refiners:
• Argentine Ministry of War
• Continental Oil Co.
• Humble Oil & Refining Co.
• Pan American Refining Co.
• Pure Oil Company
• Standard Oil Co. (Indiana)
• The Texas Company
• Union Oil Co. of California

At least 9 of every 10 barrels of hydroformed naphtha are processed in Kellogg-engineered and constructed units!

Yes! More than 90% of the total world hydroforming capacity is Kellogg-designed, engineered and constructed!

KELLOGG built its first catalytic hydroformer in 1940 for an American refiner who desired high-octane blending products without recourse to TEL.

Its success was quickly overshadowed, however, by the advent of the war when the process attained even more vital significance as an easy method for producing much-needed toluene, with the blending components relegated to by-products. Naturally, since the war these units have reverted to gasoline production, providing their owners with efficient means of staying in the vanguard of the octane-improvement race.

Historically, Kellogg developed the catalyst used in the Hydroforming process, brought the process itself into actuality through a succession of pilot plants, and designed and erected all but one of the commercial units that were built.

Flexibility of these units was underlined recently when one refiner interested in the petro-chemical market utilized his equipment (without any mechanical alterations) to produce hard-to-get synthetic benzene.

When considering methods for upgrading naphthas or for obtaining certain useful cyclic hydrocarbons for sale in the chemicals market, Kellogg's catalytic reforming experience will prove of value to any refiner.

ACHIEVE NEW STANDARDS FOR AUTOMATIC CONTROL

Kellogg specialists set new standards for ease of operation when the original hydroformer was built

ten years ago. Still standing as one of the first units to employ graphic panels, the process also uses master and dormant cycle timers for fully automatic control. Each of the steps comprising one full cycle registers *visually* on the main panel. Audible signalling equipment, to warn of any malfunction, is present, as are push-button controls for manual operation. The job is typical of the controls and instrumentation which go into Kellogg's designs today.

IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER . . .

2 PROCESS ENGINEERING
by three distinct groups of specialists—*sequence* engineers, *unit* engineers and *development* engineers—supported by an extensive reservoir of exclusive data.

3 SPECIALISTS IN EVERY PHASE
of design engineering due to the completeness of Kellogg's engineering staff.

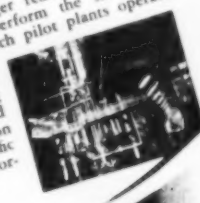
4 SPECIALIZED BUYERS
backed by the cumulative buying power of the largest company in the business.

5 COMPLETE FABRICATING FACILITIES
to make schedule deadlines and to develop workable "firsts" in refinery equipment.

6 CONSTRUCTION KNOW-HOW
acquired in completing hundreds of major jobs, plus an ample supply of the proper tools, and the constant development of new money-and-time-saving methods on the construction lot.

7 PRACTICAL OPERATING COUNSEL
on all design and construction, achieved through practical operating men working as an integral part of the company.

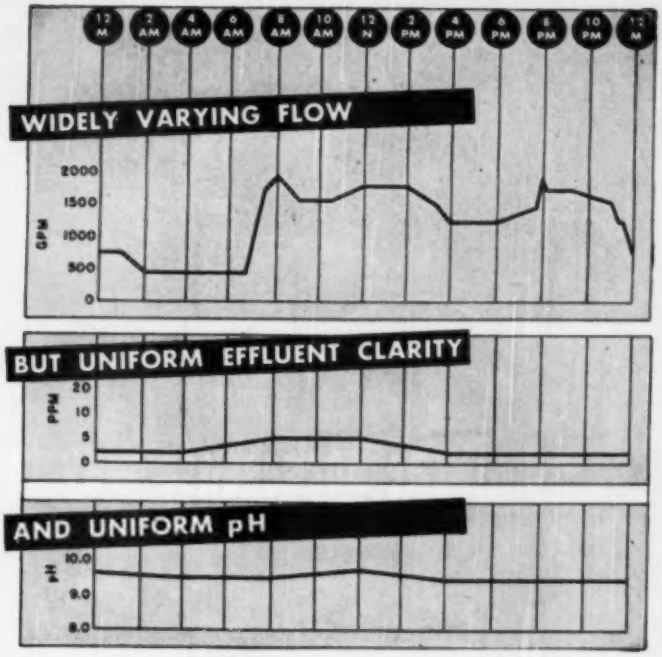
1. THE DEVELOPMENT TOOLS,
both equipment and people, to improve processing and equipment ideas. Semi-commercial size plants for testing ideas with a limited capital investment have for years been the tools of wise refiners. But Kellogg made a major contribution to refining when, in cooperation with the larger refiners, it created *one-to-two-barrel* units to perform the same job. Today more than twenty such pilot plants operate in Kellogg's laboratories, exploring refinements of existing processes, charting new processing ideas and pinpointing useful data on proposals for which specific commercial operating information is not available.



. . . AND ONLY KELLOGG HAS ALL SEVEN!

The M. W. Kellogg Company, (a subsidiary of Pullman Incorporated), New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris

A Day in the Life OF A GRAVER Reactivator



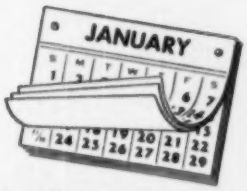
WATER CLARIFIER AND SOFTENER

The above graphs show the uniform results being obtained from a GRAVER Reactivator with widely varying flow at an installation treating a turbid surface supply.

Such results are typical of GRAVER Reactivators, for in installations throughout the country, these units maintain constantly higher clarity and quality of effluent through sudden or wide changes in flow rate and water consumption.

Highly efficient upflow clarification and softening is obtained due to the following exclusive design features . . . high rate sludge recirculation . . . upflow sludge filtration through a concentrated zone of accumulated precipitates . . . positive continuous sludge removal.

Write for catalog describing GRAVER Reactivators in detail, and ask for advice on your particular water problem. Specific recommendations from the long-experienced GRAVER engineers and chemists are offered without the slightest obligation.



It's the same story

DAY AFTER DAY
YEAR AFTER YEAR

GRAVER

GRAVER WATER CONDITIONING CO.

216 West 14th Street, New York 11, New York, U. S. A.

A DIVISION OF GRAVER TANK & MFG. CO. INC. EAST CHICAGO, IND.

the horsesense way to use horsepower

There is one best way to secure the slower speeds you need for most of your motor driven machinery . . . use Master Gearmotors . . . the horsesense way to apply horsepower.

Follow the example of the designer of this materials testing machine. See how he has used this Master Gearmotor to secure power right where he needs it . . . and at exactly the right speed. How else could he have achieved such a compact, clean-cut, economical design.

And nowhere, but in the Master line of Gearmotors, could he have found power units that are so flexible, so easily adaptable and in such a wide range of sizes and types. They are available in any size, 125 HP and smaller . . . for all cycles, phases and frequencies . . . in open, splash proof, totally enclosed, fan cooled and explosion proof types . . . with Speedrangers (mechanical variable speed) and Unibrakes . . . for every type mounting.

Increase the salability of your motor driven products . . . improve the economy, safety and productivity of your plant equipment, with Master Gearmotors . . . the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

To get all piping from one source Order it from CRANE

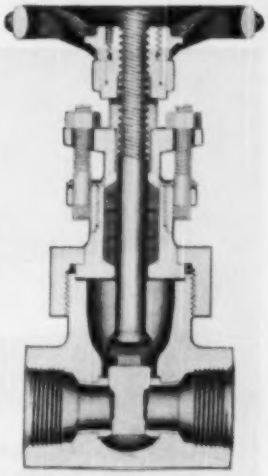
ECONOMICAL SMALL STEEL VALVES FOR OIL AND OIL VAPOR SERVICES

As a matter of fact, these rugged, compact 600-Pound Union Bonnet Gates are an economical buy in more ways than one. First of all, they're moderate in initial cost. And because they are Crane Quality in design, construction and materials . . . routine maintenance costs are negligible.

Stuffing box provides liberal packing space to assure a tight stem seal; male and female bonnet joint is equipped with a soft iron gasket for maximum tightness; body seat rings, securely rolled into place, will not loosen in service.

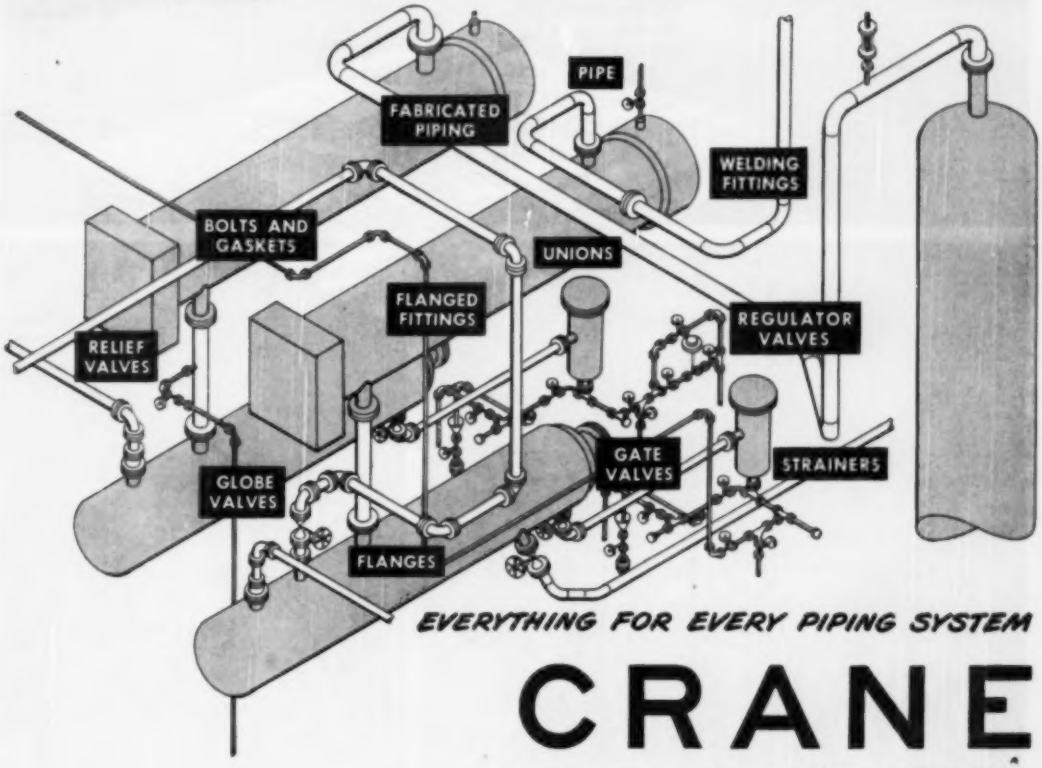
These valves are smooth operators. Guided disc does not get out of line or jam in body. Crane disc-stem connection prevents lateral strain on stem. Accurately cut, easily lubricated stem threads provide positive control with minimum friction. See your No. 49 Crane Catalog.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



No. 3602X, 600-Pound Small Steel Gate for oil or oil vapor up to 1000° F. Exelloy to Exelloy seating. Sizes: ¼ to 2-inch. Screwed or welding ends.

ONE ORDER TO CRANE CAN COMPLETELY EQUIP THIS VAPOR RECOVERY PROCESS PIPING INSTALLATION

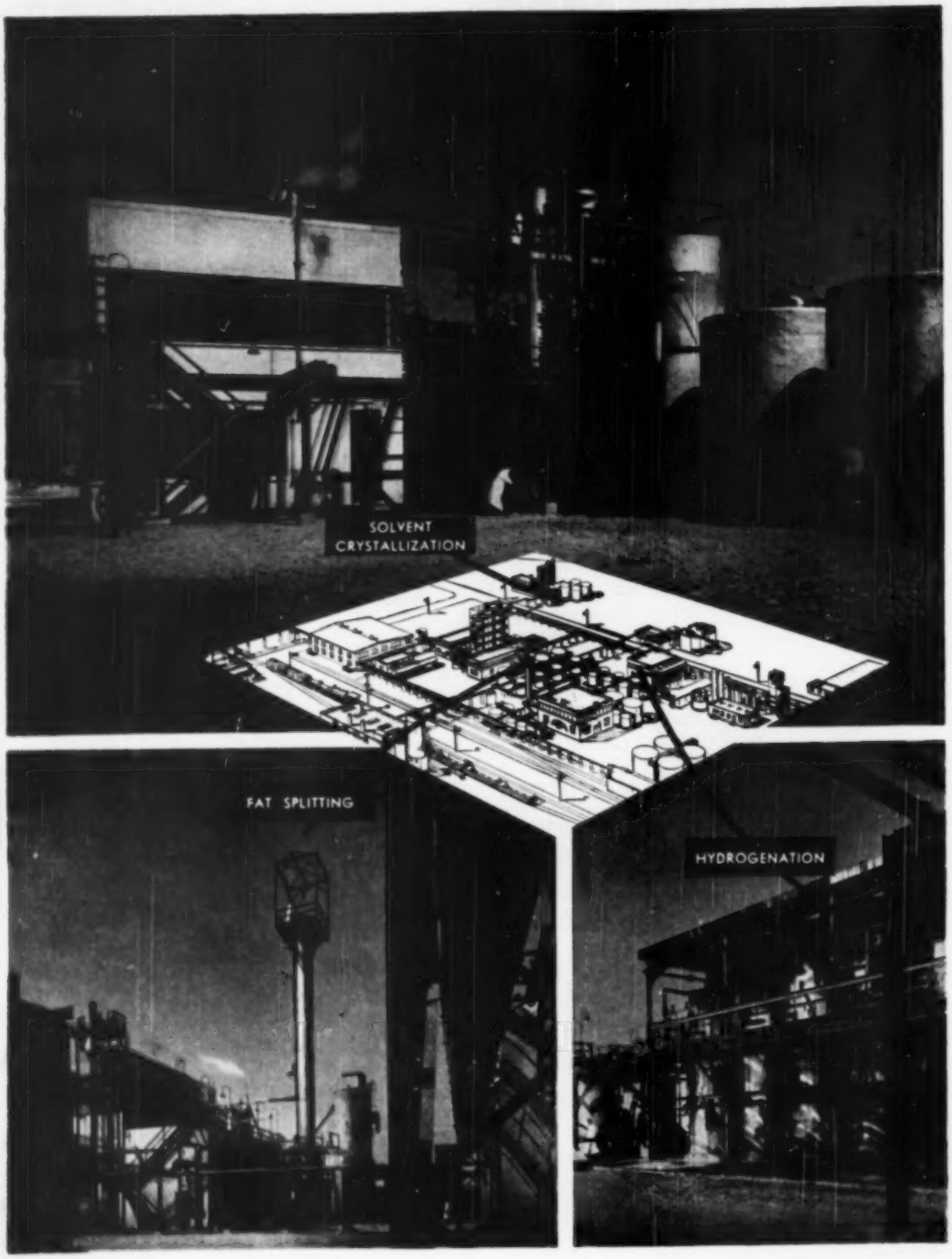


EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

A New Process for Separating Fatty



Acids by Fractional Crystallization

ANOTHER BADGER FIRST

The Fatty Oil Fractional Crystallization Process utilizing solvents as a means of separating fatty acids offers the industry an opportunity to make a wide variety of products of high purity and excellent yield at low operating cost.

A new Fatty Acid Fractional Crystallization unit, engineered and constructed by Badger, is now in successful operation at Armour's McCook, Illinois, plant. This unit permits separations with solvent over a wide range of operating temperatures. As a result, a variety of charge stocks can be processed and products of widely divergent characteristics manufactured.

This is a part of Armour's integrated plant for processing of animal and vegetable fats, designed on the basis of developments and extensive experience of Armour and Texaco, and engineered and constructed by Badger with the exception of three specialized units furnished by others. Among the Badger-built units, as well as the crystallization unit, are installations for fat splitting, hydrogenation, refining and bleaching, product finishing and a boiler house, waste recovery system, tankage, warehousing and shipping, and all auxiliary facilities.

The Fatty Oil Fractional Crystallization unit is operated under license from the Texaco Development Corporation. Into this unit Badger has built the "know-how" of both Texaco and Armour. This is another example of Badger's unique ability to convert basic design of a new development into a successful commercial plant.

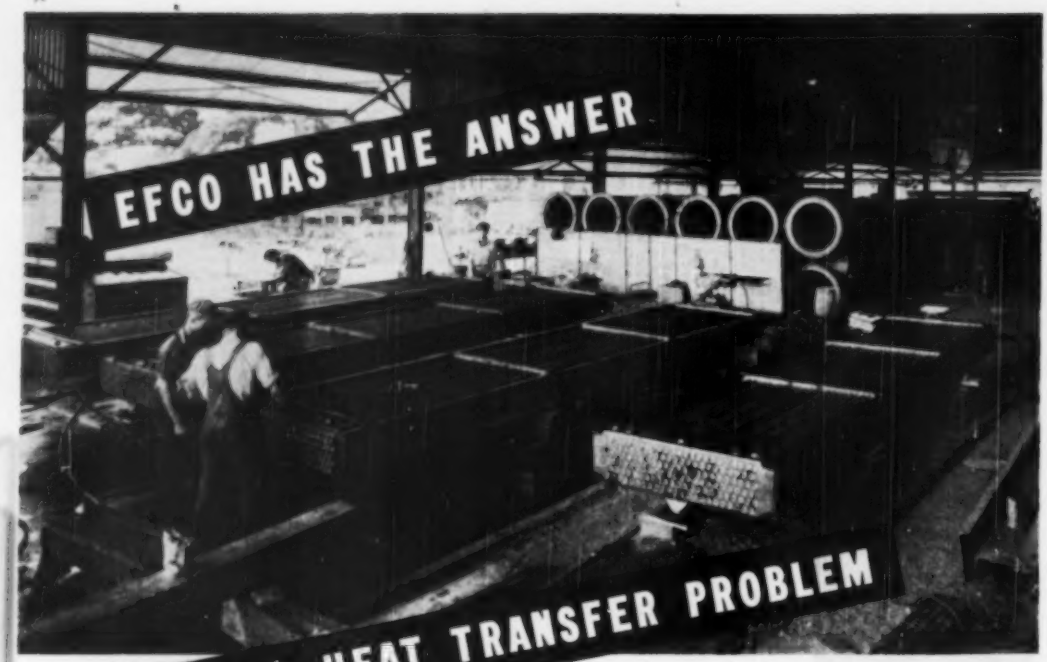
E. B. BADGER & SONS CO · Est. 1841

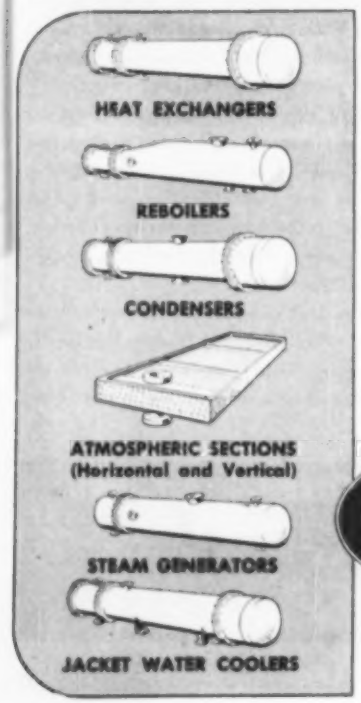
A SUBSIDIARY OF STONE & WEBSTER, INC

BOSTON 14 · NEW YORK

PARIS Etablissements Badger S. A. · LONDON E. B. Badger & Sons (Great Britain) Ltd.

Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries





● If your problem is the poor performance or high maintenance cost of your heat transfer units, consult an EFCO engineer. He will help you decide the changes or modifications necessary to get the desired performance from your heat transfer equipment.

Backed by knowledge and experience, EFCO engineers are constantly working to produce heat transfer units that will give efficient performance and long, trouble-free operation.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO
HEAT TRANSFER EQUIPMENT

SERVICE WHENEVER YOU NEED IT!
A. H. McMAHON VANCOUVER
FISHER ENGINEERING & SUPPLY CO. CALGARY
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JOHN H. CARTER CO. NEW ORLEANS
JOHN H. CARTER CO. LAKE CHARLES
PUFFER-SWEIVEN CO.
FISHER
WAREHOUSE STOCKS
AND
ENGINEERING SERVICE
This nationwide network of 47 representatives—with over 150 Fisher Service Engineers—and 9 strategically located warehouse stocks—offers you immediate and convenient service on all your control requirements. Whether your problem concerns existing equipment or an entirely new control application, you'll find Fisher engineers ready to help with experienced, expert advice and counsel.
FISHER GOVERNOR CO., Marshalltown, Iowa
Legends
INDICATES WAREHOUSE STOCK
INDICATES SALES ENGINEERING OFFICE

Two of several wool bins in the Hardwick and Magee Spinning Mill—built with K&M APAC.

ON GUARD: K&M "Century" APAC

When raw wool or processed wool is stored in bulk, there's danger of fire—not only from external causes, but also from spontaneous combustion. That's one of the reasons the Hardwick and Magee Company, nationally known carpet and rug manufacturers, chose K&M APAC for the construction of these wool bins in their modern spinning mill.

K&M APAC—specially processed sheets of asbestos-cement—resists fire effectively and dependably. The smooth, hard finish of APAC prevents fibrous matter and dust from adhering to the surface—reduces materially the opportunity for fire to spread. And K&M APAC stops the other enemies of raw materials, also—weather, rust, rot, termites, and rodents can't affect it.

You'll like the installation economies you get from using K&M APAC, too. Sheet sections are large (4' x 8') and strong, but not bulky; they handle easily, can be cut and fitted on the job, are quickly erected. And you save on maintenance costs, too, for K&M APAC doesn't need even paint to preserve its attractive finish.

It will pay you to consider K&M APAC Asbestos-Cement Sheets for such needs as panels, partitions, sheathing, shaft casings, bins, in fact, for all flat surfaces both interior and exterior. APAC can be applied over insulation boards, wood studs, solid wood sheathing, steel or wood girts. It's adaptable and economical—the perfect answer to flat surface covering problems.

GET THE COMPLETE STORY—write us for details and the name of your nearest distributor. There's no obligation, of course.

Nature made Asbestos . . . Keasbey & Mattison has made it serve mankind since 1873

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

...not a Jack-of-All-Trades...just MASTER of ONE

The proverbial handy man never reached big league stature in any of his jobs. And no single material is master of all corrosion and heat problems found in your plant.

That is why *ESCO* casts not only the commonly used or "standard" stainless steels, but also works in special analyses required to fit specific operating conditions. Thus, the following analyses have been used in manufacturing equipment for chemical plants and refineries throughout the country:

ESCO ALLOY 20 for pumps, piping and fittings.

ESCO ALLOY 32 (T410) for valves, fittings and refiner parts.

ESCO ALLOY 45 (T317) for equipment to handle corrosive fluids.

ESCO ALLOY 43 (T309) for stills and furnace parts subject to corrosion and extreme temperatures.

Perhaps somewhere in your plant there is a trouble zone where trouble from corrosion and heat has been excessive, and where *ESCO* metallurgical experience and special stainless steels can provide a workable solution.

ESCO welcomes your consultation. See your nearest *ESCO* representative, or write full particulars of your problem including the corrosive agents used, their concentrations, temperatures, pressures, etc. The *ESCO* catalog of stainless and high alloy steels outlines our facilities and services. Fill in and mail the coupon, and you will receive a copy promptly.

ESCO STAINLESS AND HIGH ALLOY STEELS

ELECTRIC STEEL FOUNDRY

2181 N. W. 25th Avenue, Portland 10, Oregon

Sales Offices and Warehouses

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Please send your catalog on Stainless and High Alloy Steels to

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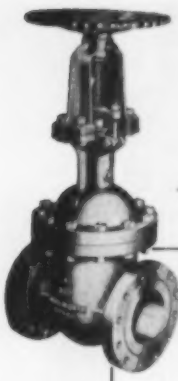
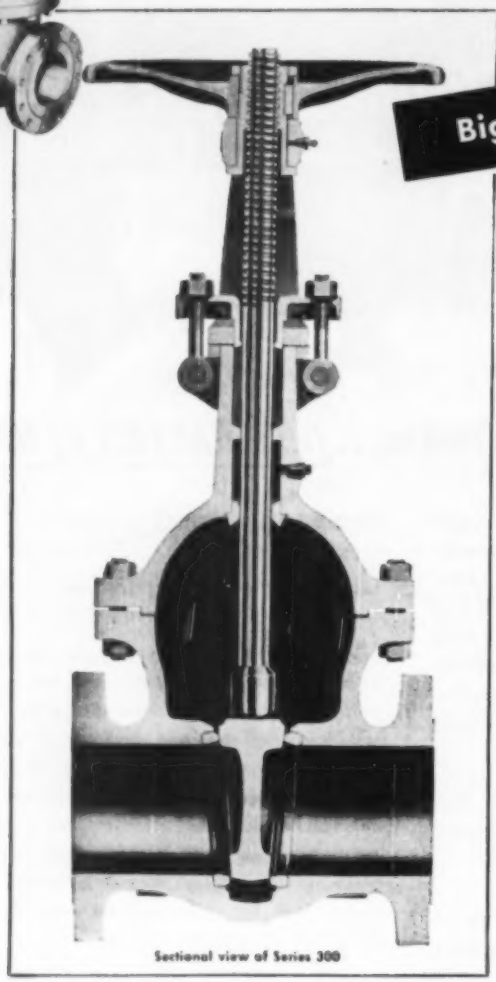
WALWORTH

Cast Steel Gate Valves

Series 150 and 300

Wedge Gate — Outside Screw and Yoke





Sectional view of Series 300

Big 8-Point Superiority!

Gland clearances are such that stem cannot be scored if gland should be tightened unevenly.

Deep Stuffing Boxes in all sizes (2" to 24") insure tightness and maximum packing life — costly leaks are eliminated.

Bonnets and Bodies are engineered to withstand pressure and minimize distortion — they're tough, durable, dependable.

Heavy Steel Walls provide extra strength and longer life.

Integral Body Guide Rib Faces are machined to insure accurate disc seating.

Seat Rings are bottom seated — not flange type. No recess exists at back of ring — hence no turbulence, erosion, or pressure drop.

Streamlined Ports allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

Valves regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.

For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

WALWORTH

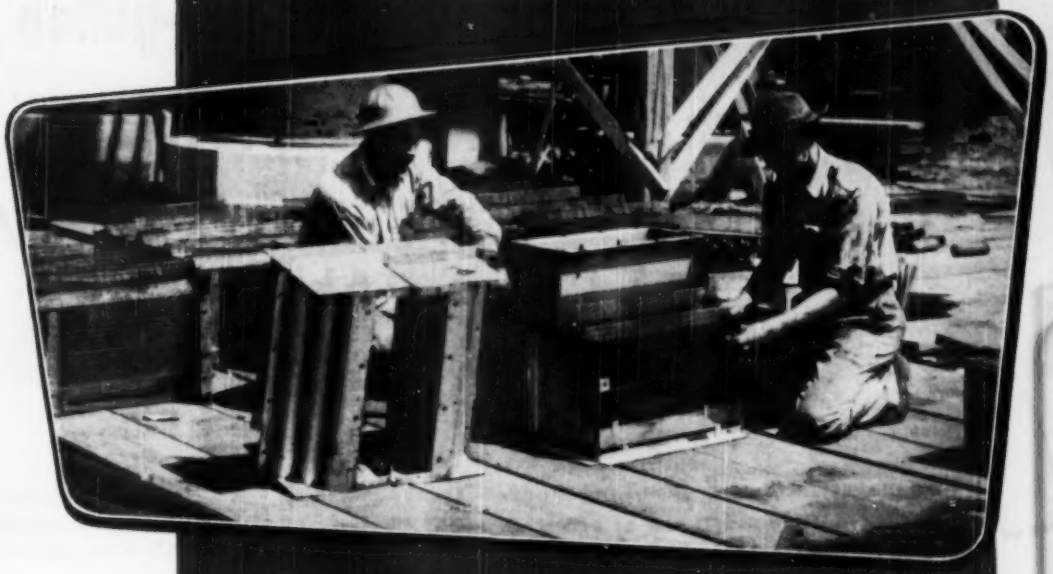
valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

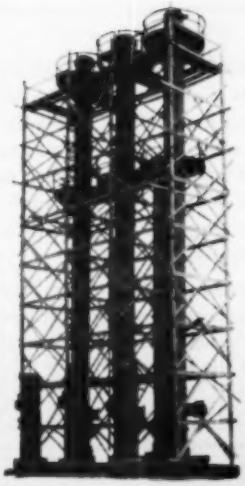
NUMBER 2 OF A SERIES

Our installation time was only 1½ manhours for each 3-foot tray



and the Koch Kaskade fractionating trays in our new gasoline plant are operating fine!

PEPPERS REFINING COMPANY

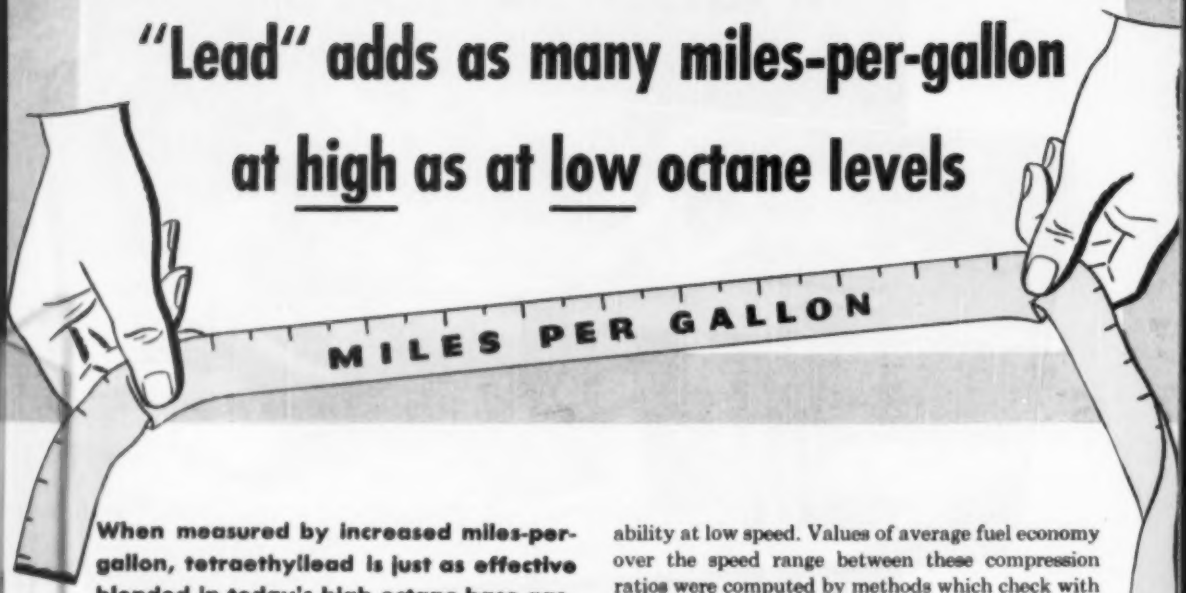


SATISFIED by the operation of Koch Kaskade trays in another of their gasoline plants, Peppers naturally specified them in all the towers of their new gasoline plant at Britton, Oklahoma. These towers include an absorber, stripper, deethanizer, depropanizer and a debutanizer.

A LARGE number of Koch Kaskade tray installations are repeat orders from satisfied customers. It will pay you to investigate the economy and operating efficiency of Koch Kaskade fractionating trays. Write us today, no obligation.

THE KOCH ENGINEERING COMPANY, INC.

"Lead" adds as many miles-per-gallon at high as at low octane levels



When measured by increased miles-per-gallon, tetraethyllead is just as effective blended in today's high octane base gasolines as in the lower octane gasolines of the past.

THERE has been a remarkable increase in the antiknock quality of base gasolines since "Ethyl" antiknock compound was first marketed in 1923. Despite this large increase in the octane number of base gasolines, tetraethyllead is just as effective as ever from the standpoint of the extra miles-per-gallon it can contribute.

The charts show data obtained in tests made at 6.1 and 8.5 compression ratios on an automobile equipped with an overhead valve engine, and with axle ratios selected to provide equal acceleration ability at low speed. Values of average fuel economy over the speed range between these compression ratios were computed by methods which check with experiment.

Chart No. 1 shows that permissible increase in compression ratio per octane unit becomes larger as the octane number of the fuel is raised, and shows that octane numbers at the higher levels are increasingly effective in the improvement of gasoline economy on the road.

From 6.1 to 8.5 compression ratio (corresponding to an increase in octane number from 78.3 to 95) miles-per-gallon of fuel are boosted by approximately 19%. In contrast, the air cycle efficiency increases only about 11% over the same range of compression ratio.

In Chart No. 2 the gasoline mileage curve of the lower chart is repeated. On the curve, the two circles show the improvement contributed by 3.0 cc tetraethyllead when added to a base fuel of 78.3 octane number. The two squares show the gain from 3 cc tetraethyllead when added to a base fuel of 86 octane number. *The additional miles-per-gallon* are substantially the same in the two cases.

Thus, when tetraethyllead is added to commercial fuels, it is just as effective for improving fuel economy on the road at today's high octane levels as at the lower octane levels of the past.

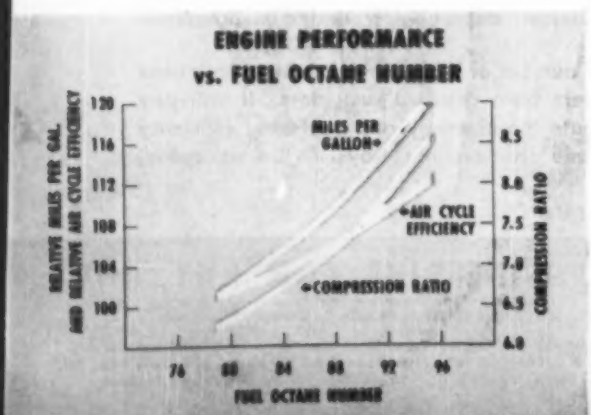


CHART 1. The improvements, per octane unit, of air cycle efficiency, miles-per-gallon and permissible compression ratio become greater as the antiknock value of the fuel is increased.

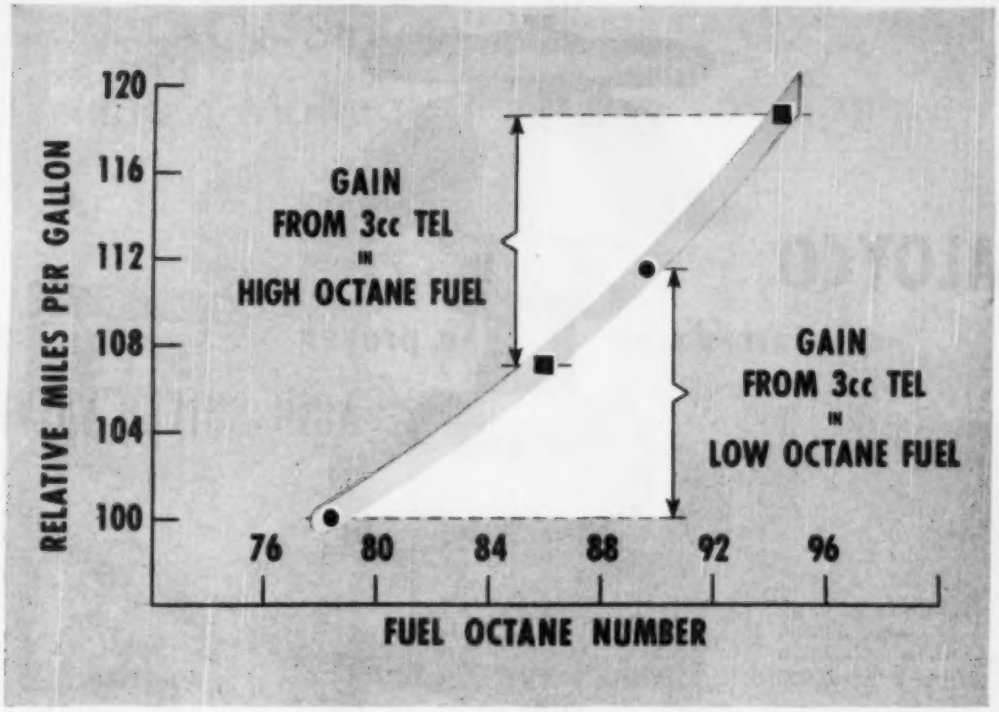


CHART 2.

Research has indicated that some types of hydrocarbons in the higher octane range are unusually responsive to additions of tetraethyllead. The production and use of such stocks in the future may bring substantial economies in the manufacture of gasolines of high antiknock quality.

Future messages will cover the relation of the chemical composition of gasolines to the effectiveness of tetraethyllead.

Members of the Ethyl research staff are pleased to discuss these findings with refiners who are formulating long-range research programs.

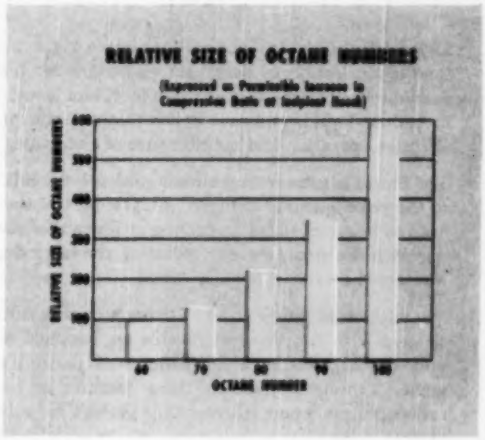


CHART 3. This chart shows that the units going up the octane scale become larger and larger in terms of permissible increase in compression ratio.

Over 400 specialists working full time on fuel and engine developments

ETHYL CORPORATION
RESEARCH LABORATORIES

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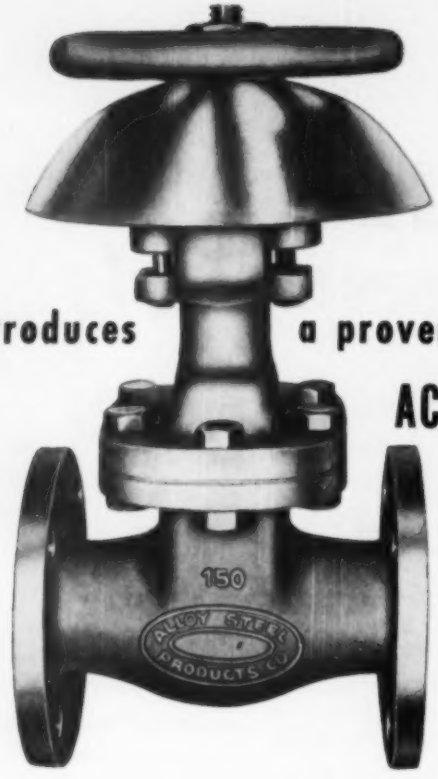
ALOYCO introduces a proven ACID SHIELD VALVE



No. 111-AS Gate Valve—same design as regular No. 111 with acid shield added. Size range ½"-10".

No. 110-AS Gate Valve—same design as regular No. 110 with addition of acid shield. Size range ½"-4".

No. 311-AS Globe Valve—same design as regular No. 311 with acid shield added. Size range ½"-6".

Aloyco Acid Shields are designed to meet rigid plant safety codes for the protection of personnel and minimize maintenance. They adequately protect the operator's face, hands and upper body from hazardous liquids and accomplish this without interfering with the effective operation and maintenance of the valves.

The Shield is spun from stainless steel sheet and is securely fastened to the yoke bushing. Being an integral part of the valve it does not need to be removed for inspection or renewal of packing. It does not rise with the stem, thereby affording the same degree of protection whether the valve is open or closed.

For additional safety and to further reduce maintenance, all valves ordered with Aloyco Acid Shields are supplied with stainless steel yoke bushings and nuts and Teflon stem packing as standard equipment. The initial cost of these features is nominal and many satisfied users report maintenance savings are substantial.

Send for further information.

Aloyco Acid Shield Valves are available in Aloyco 20, 18-8S, 18-8SMo, Monel, Nickel, and other alloys. Regularly equipped with Teflon-packing and stainless steel yoke bushings.

Aloyco Valves are manufactured in compliance with the new MSS Stainless Steel Valve Standards S.P.-42.

ALLOY STEEL PRODUCTS CO., Inc.

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ATLANTA — CHICAGO — HOUSTON — LOS ANGELES — NEW YORK — PITTSBURGH — WILMINGTON

On Stream *Automatically* without Manual "Juggling" of Control!

Twin naphtha rerun stills at El Segundo Refinery of Standard Oil Company of California, built by C. F. Braun, Co.

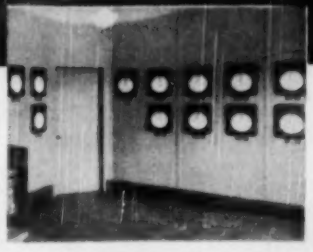
. . . *thanks to Foxboro M-40 Controllers*

At the El Segundo Refinery of the Standard Oil Company of California, fast, sure start-ups typify the operation afforded by M-40 Controllers on two new naphtha rerun stills.

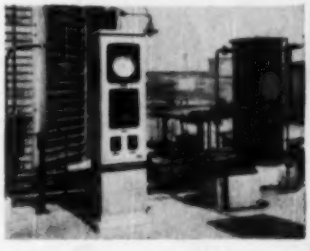
Because each pre-set value is so accurately met by the M-40 Controllers, every process temperature, pressure and flow rate comes directly to its control point without any manual "babying". And the inherent stability of M-40 control action *holds* it there, for maximum process-uniformity.

The Foxboro M-40 Controller gives you the benefit of the most advanced developments in the field of pneumatic instrument design. Its rigid unit construction and almost frictionless moving parts result in greater power, accuracy, and sensitivity. Available for temperature, pressure, flow, level and other applications.

Write for details. **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U. S. A.**

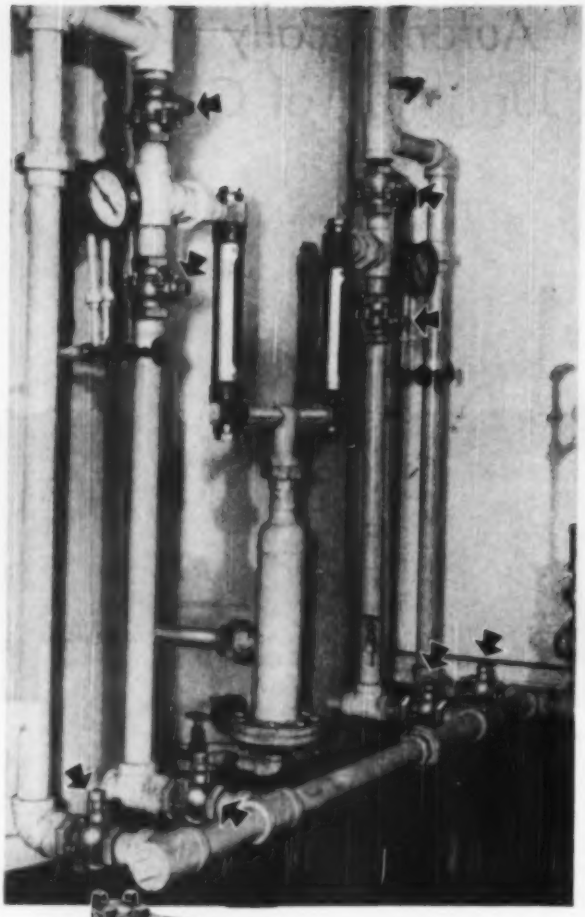


One corner of the control room, showing a few of the M-40 Controllers which automatically operate the process.



pH controller for cooling tower. It holds pH of process cooling water within desired limits.

FOXBORO Reg. U.S. Pat. Off. **CONTROLLERS**



REDUCE
maintenance cost
with
ROCKWOOD
BALL TYPE
VALVES

Longer service life with no maintenance is a primary advantage of the Rockwood Ball Type Valve that pays off in dollars and cents year in and year out.

The maintenance engineer of this large gas company was quickly convinced that his choice of Rockwood Valves for gasoline lines on "sweetening towers" had been sound. Says this engineer, "The full *round* flow, leak proof service, easy operation and no maintenance cost make Rockwood Valves far ahead of any competitive valve we used."

Rockwood Valves are today giving excellent performance on difficult operations in oil refineries, food, paper, chemical and rubber plants, etc. It will pay you to specify and buy Rockwood Valves. Send for bulletin V-4. Distributors in all principal cities.

... YOU'LL PROFIT EVERY DAY WITH THESE FEATURES!

1. Full round open area - no turbulence in fluid stream.
2. Leak proof after continued use.
3. New floating ball - resists pitting, scratching and abrasion.
4. No exposed seating surface in open or closed position.
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6. Installed in any position.
7. Quarter turn (90°) opening and closing valve.

Rockwood Valves are recommended for 300 p.s.i. working pressure. Made in bronze with screwed ends in all pipe sizes from ½" to 2".

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UNCOMPLICATED
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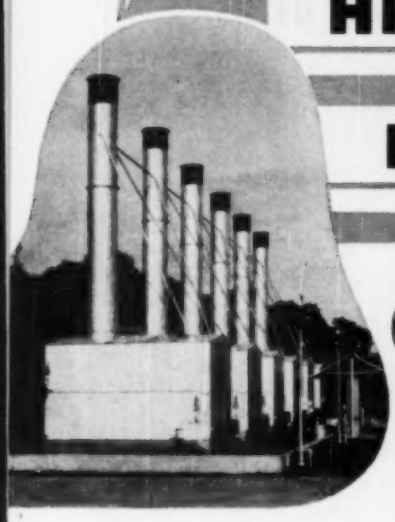


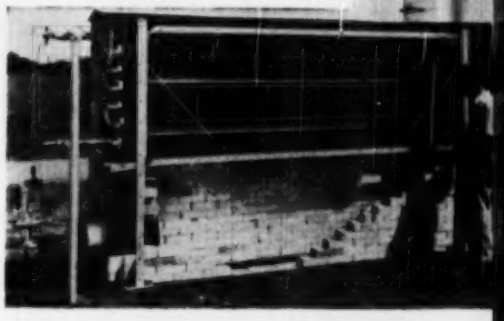
Fluid Heating

• Where your problem is corrosives, caking or high temperatures with high or low pressures . . . a ready answer is the BS&B Tubular Heater. Developed to deliver dependable heating under even the most severe field conditions, the Tubular Heater is built like a pipe still. Straight pipe tubes are suspended above a spacious firebox, linked together with an ingenious return bend.

Cleaning can be quickly accomplished. Replacement is made easily from your inexpensive yard pipe. Firebox is lined with ordinary brick, laid up dry. Properly balanced to deliver high fluid velocities and high thermal efficiency. Automatically controlled.

Standard models offer 20 to 120 two-inch tubes . . . or 12 to 72 four-inch tubes. Maximum working pressures up to 2,100 psi, maximum heating capacities to 4,200,000 BTU per hour. Fully illustrated catalog now ready . . . send coupon today!

Cut-away view, showing exclusive return bends, pipe tubes and firebrick. BS&B-engineered for simplicity and efficiency!



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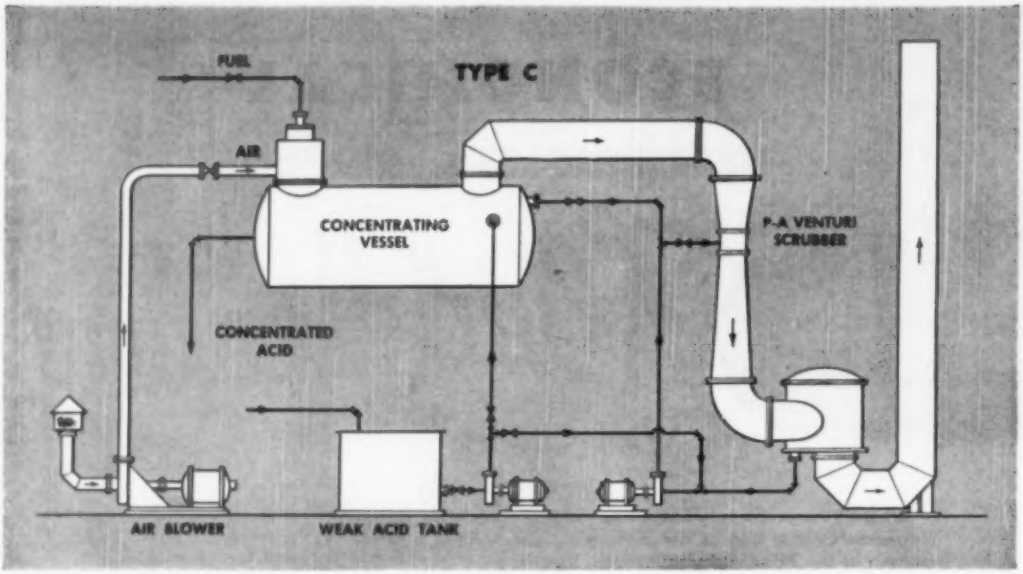
Chemico Offers

NEW HIGH TEMPERATURE CONCENTRATOR

for spent sulfuric and phosphoric acids



THE NEW TYPE C High Temperature Acid Concentrator is a major improvement on the well known Chemico Drum Type Concentrator. This new unit is specially designed for concentrating spent sulfuric acid from petroleum refining, alcohol synthesis and nitrating operations as well as phosphoric acid from triple superphosphate operations.

The Type C unit employs the same principle as the Drum Type. Hot combustion gas is released under the surface of the acid where it gives up most of its heat and emerges at a temperature slightly above that of the acid itself. The combustion of the fuel takes place in the dip pipe, which withstands a high temperature on the *inside* and the corrosive action of acid on the *outside*.

But the new Type C Concentrator uses combustion gas at 2500F instead of 1100F. This high-temperature operation provides greatly improved heat efficiency. It also produces a much smaller volume of gas to be scrubbed at the concentrator exit. Here Chemico utilizes the recently developed and highly efficient P-A (Pease-Anthony) Venturi Scrubber which eliminates up to 99% of acid mist.

SEND FOR CHEMICO BULLETIN S-112, which fully describes this new Type C unit as well as the Type S Concentrator for acids containing soluble salts.

ADVANTAGES OF THIS NEW CHEMICO UNIT

1. Use of high temperature combustion gas assures high heat efficiency.
2. Retains the best features of the Chemico Drum Type Concentrator.
3. Low initial investment.
4. Low operating cost.
5. Low maintenance cost.
6. Acid concentration through all ranges of strength up to 96%.
7. High acid recovery.
8. Built-in fume eliminator (P-A Venturi Scrubber).
9. Specially adapted for use on acids containing salts as, for example, waste pickling solutions.
10. No heat transfer surfaces to coke up.
11. Fully guaranteed by Chemical Construction Corporation who have more than 35 years of experience in this field and a background of more than 200 successful concentrating unit installations.

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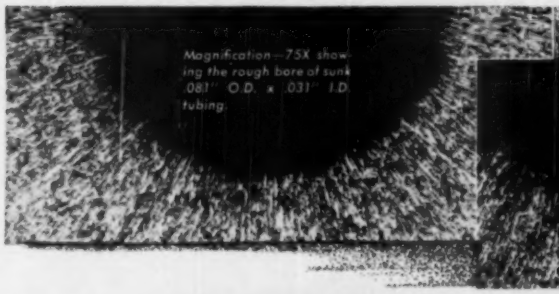
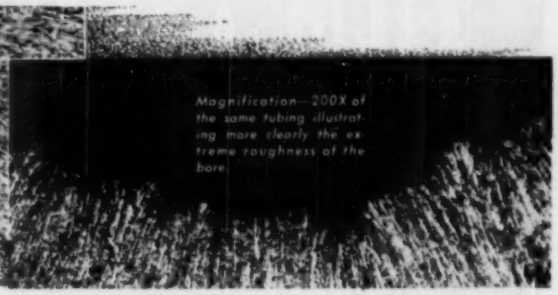
These photomicrographs show the transverse sections of three brands of capillary tubing.

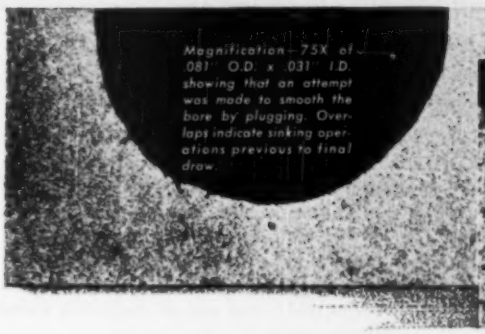
They tell their own stories and prove the truth of our statement that "There IS a difference in tubing."



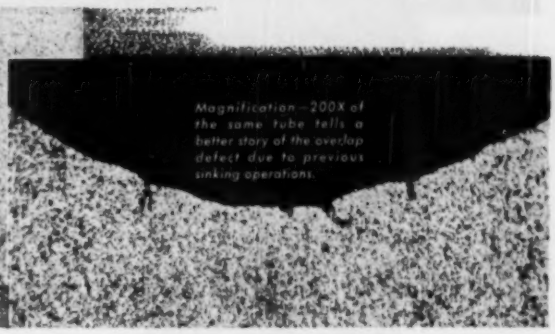
Magnification—75X showing the rough bore of sunk .081" O.D. x .031" I.D. tubing.



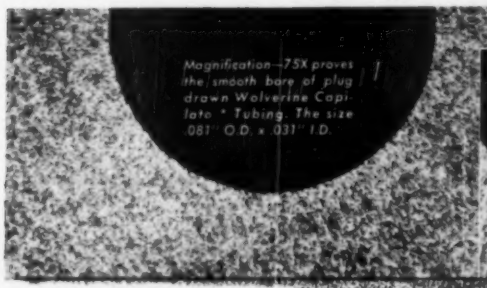
Magnification—200X of the same tubing illustrating more clearly the extreme roughness of the bore.



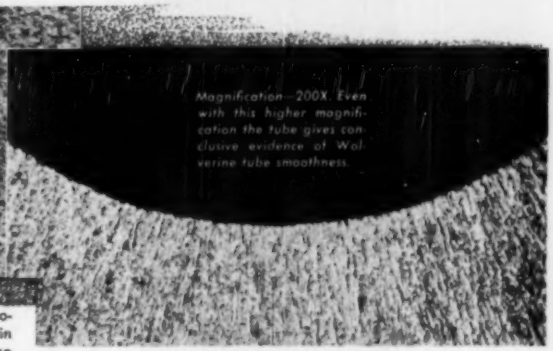
Magnification—75X of .081" O.D. x .031" I.D. showing that an attempt was made to smooth the bore by plugging. Overlaps indicate sinking operations previous to final draw.



Magnification—200X of the same tube tells a better story of the overlap defect due to previous sinking operations.



*Magnification—75X proves the smooth bore of plug drawn Wolverine Capilato * Tubing. The size .081" O.D. x .031" I.D.*



Magnification—200X. Even with this higher magnification the tube gives conclusive evidence of Wolverine tube smoothness.

All these reproductions were made from unretouched photomicrographs. While capillary tube was used as an example, bear in mind that this small sized tube was drawn from the same base size (3" O.D.) used to produce all other sizes of Wolverine tube. Thus this evidence of quality applies to ALL Wolverine tube, regardless of size.

Which tube would you choose? Of course, you'd choose the tube which would allow the smoothest flow of liquid or gas—and, in the long run, give you the most economical service. You'd choose dependable Wolverine tube.

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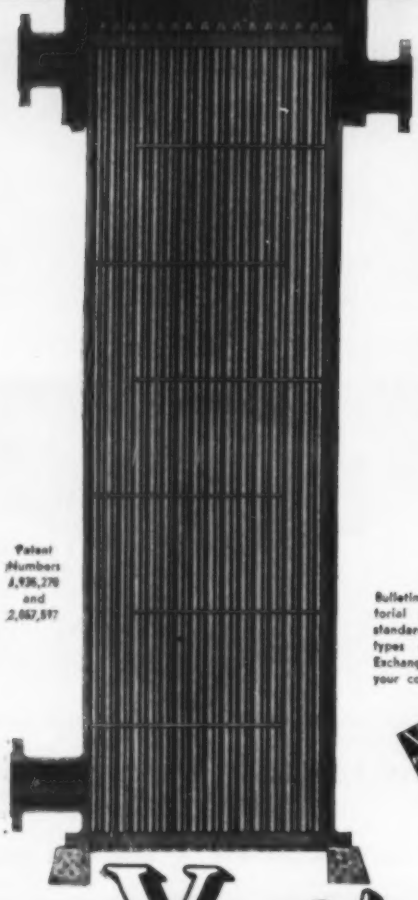
FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,936,270 and 2,057,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

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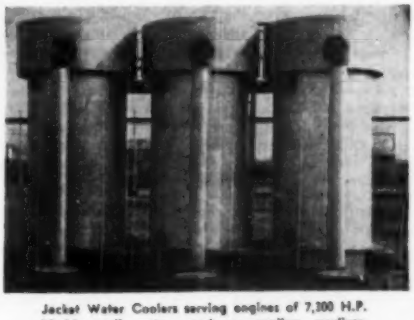
Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.

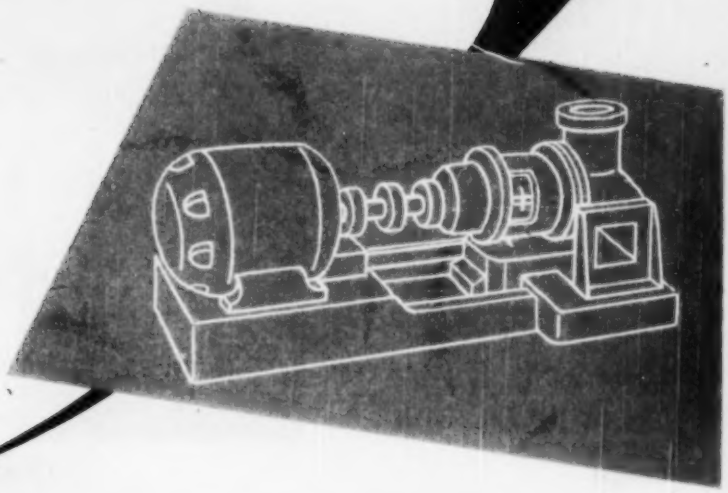


Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

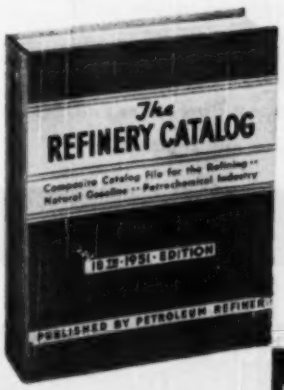
18 Hot Oil Pump MANUFACTURERS HAVE THEIR CATALOGS FILED IN REFINERY CATALOG



FAST SPECIFYING IS EASY WHEN YOU HAVE ADEQUATE INFORMATION

WHETHER you are specifying hot oil pumps, packing gaskets or a cracking still, you'll find it easier to compare, easier to decide when you look it up in Refinery Catalog. You'll find most, if not all, of the known manufacturers of the product you have in mind have their catalogs filed in Refinery Catalog. The new Refinery Catalog carries buying information on approximately 2,000 types of process plant equipment made by more than 300 manufacturers.

Find it quicker—look it up in Refinery Catalog.


The
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Composite Catalog File for the Refining -- Natural Gasoline -- Petrochemical Industry
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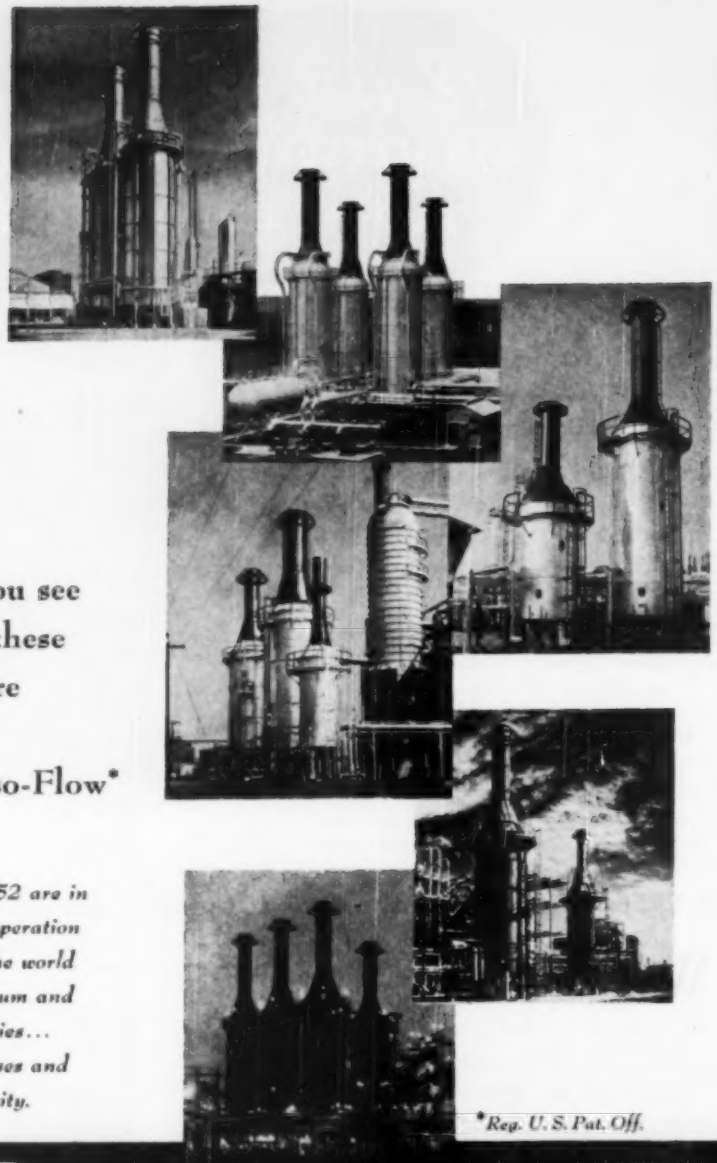
THE UNIVERSAL EQUIPMENT GUIDE FOR REFINERY BUYERS



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More than 052 are in satisfactory operation throughout the world in the petroleum and allied industries... for all processes and for any capacity.

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There's a Petro-Chem Iso-Flow Furnace and Boiler for every service, capacity or duty, irrespective of temperature pressure ranges . . . none too small or too large . . . more than 052 in operation throughout the world in the petroleum and allied industries performing with utmost satisfaction . . . and in many instances operating in excess of their design capacity by more than 50%.

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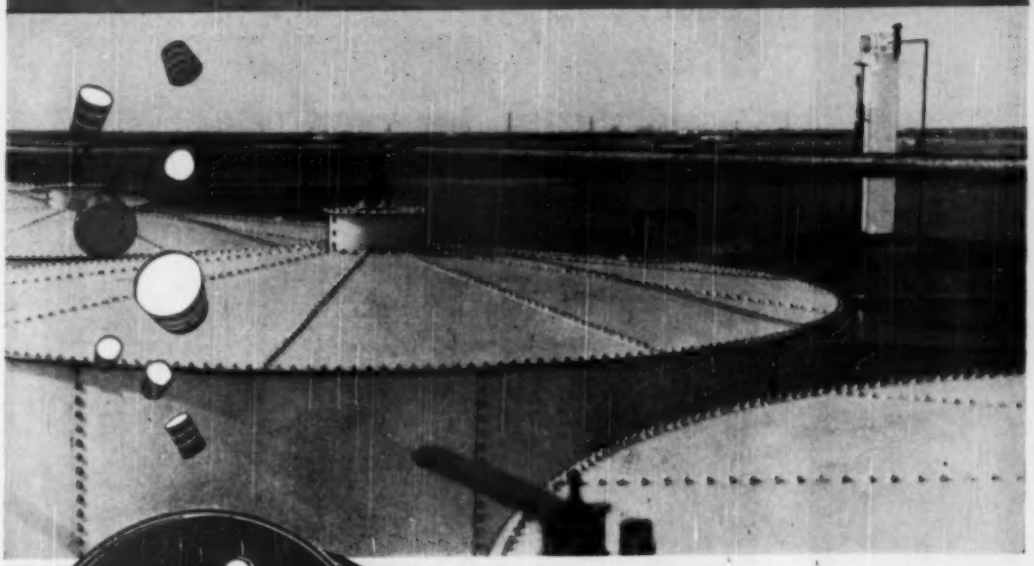

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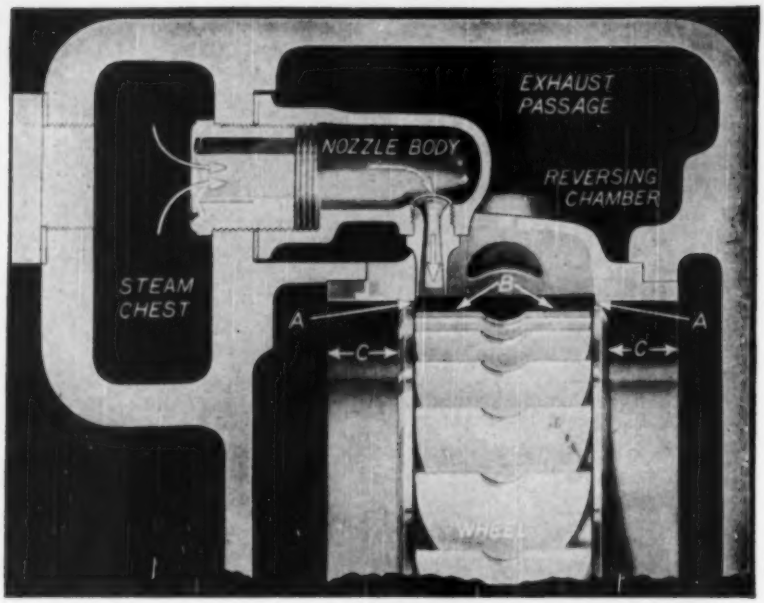

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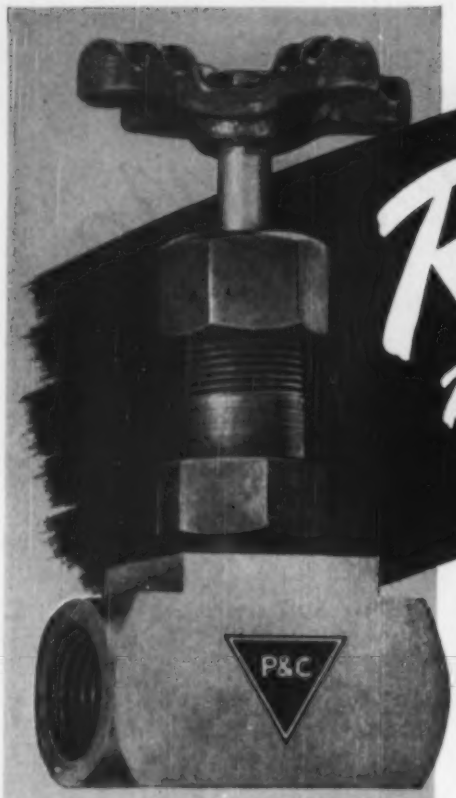

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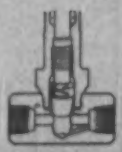
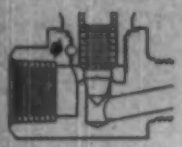


THRU-PORT—for handling heavy liquids which carry suspended solids or where precipitates or deposits cause trouble.

MALE and FEMALE END—Available in both Globe and Angle valves—useful for many special hook-ups.

(SOCKET WELDING ENDS NOT ILLUSTRATED)



LOCK BONNET—for lines carrying hazardous liquids or where there is extreme vibration.

UNION END—where frequent disassembly is required or to use instead of a brush elsewhere in the line.

Following is a tabulation of working pressures of these valves:

MATERIAL	FIGURE NO. Globe	Angle	WORKING PRESSURE
BRONZE	1030	1031	500 lbs. at 150°F
CARBON STEEL	1040A	1041A	4000 lbs. at 150°F
			600 lbs. at 750°F
			550 lbs. at 900°F
			475 lbs. at 1000°F
12-14 CHROME STAINLESS STEEL	1050	1051	4000 lbs. at 150°F
COMBINATION	1060	1061	4000 lbs. at 150°F
12-14 CHROME			600 lbs. at 750°F
STAINLESS STEEL			550 lbs. at 900°F
CARBON STEEL			475 lbs. at 1000°F
18-8 STAIN. STEEL (TYPE 316)	1070A	1071A	4000 lbs. at 150°F
THRU PORT VALVES 1045A			1000 lbs. at 150°F
			600 lbs. at 750°F
			550 lbs. at 900°F
			475 lbs. at 1000°F

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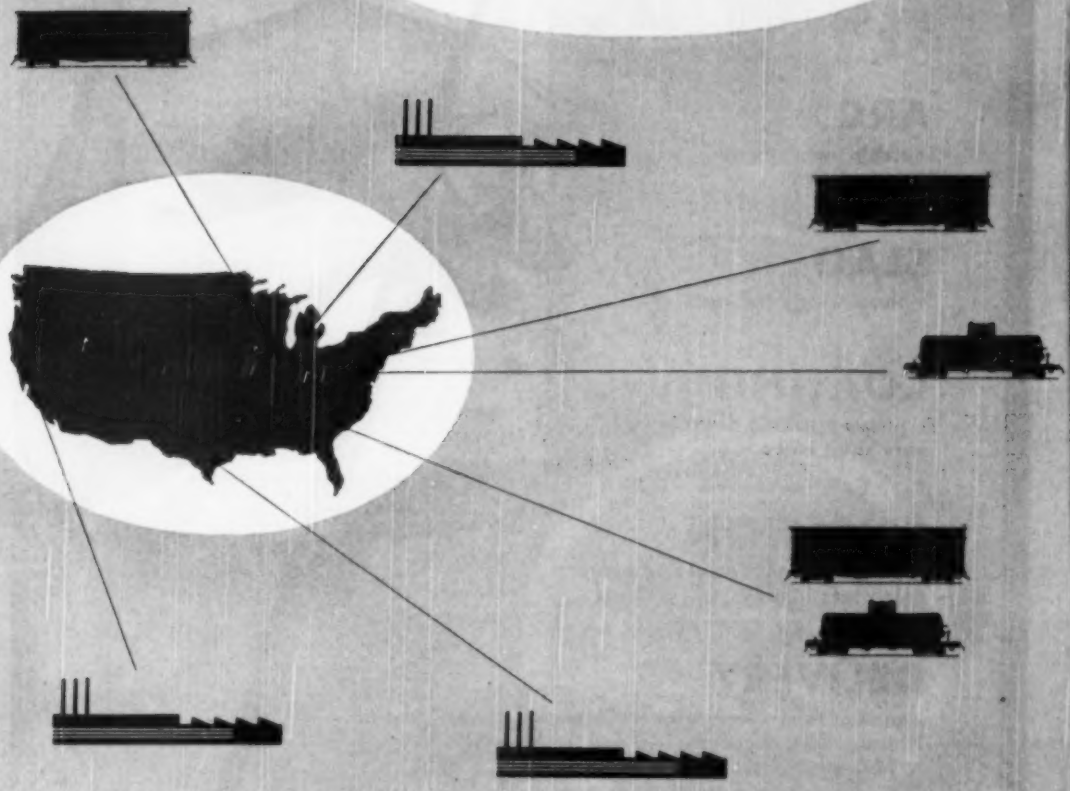

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Du Pont Announces

"ORTHOLEUM" 300 GREASE STABILIZER

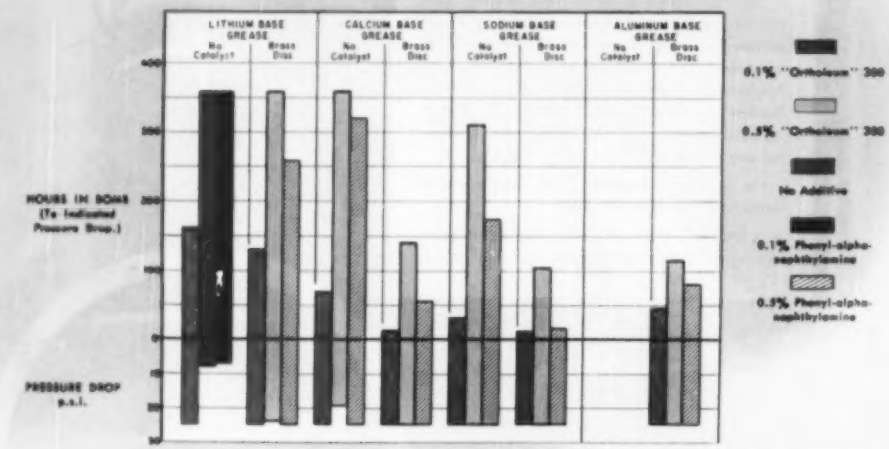
SEND FOR SAMPLES . . . to evaluate in your own greases. Write the nearest District Office or ask your Petroleum Chemicals representative for samples. Also, for more complete information ask for Technical Bulletin GS-50.

To help meet the demand for greases of higher stability to stand up under the higher temperatures and loads of many present-day grease applications, Du Pont has developed "Ortholeum" 300 Grease Stabilizer. This new additive combines both antioxidant and metal deactivating properties. The combination imparts oxidation stability to the grease superior to that attainable with antioxidants alone and in addition does not cause discoloration of the finished product.

The effectiveness of "Ortholeum" 300 has been evaluated in many types of greases and laboratory tests show marked superiority over compounds such as Phenyl-alpha-naphthylamine. This is indicated in the chart below which gives results of Norma-Hoffman Oxidation Tests on several greases.

"Ortholeum" 300 is easily added to the grease during manufacture and cost of using it is very low. For the normal concentrations, treating cost runs only around .4¢/lb.

NORMA-HOFFMANN OXIDATION TEST



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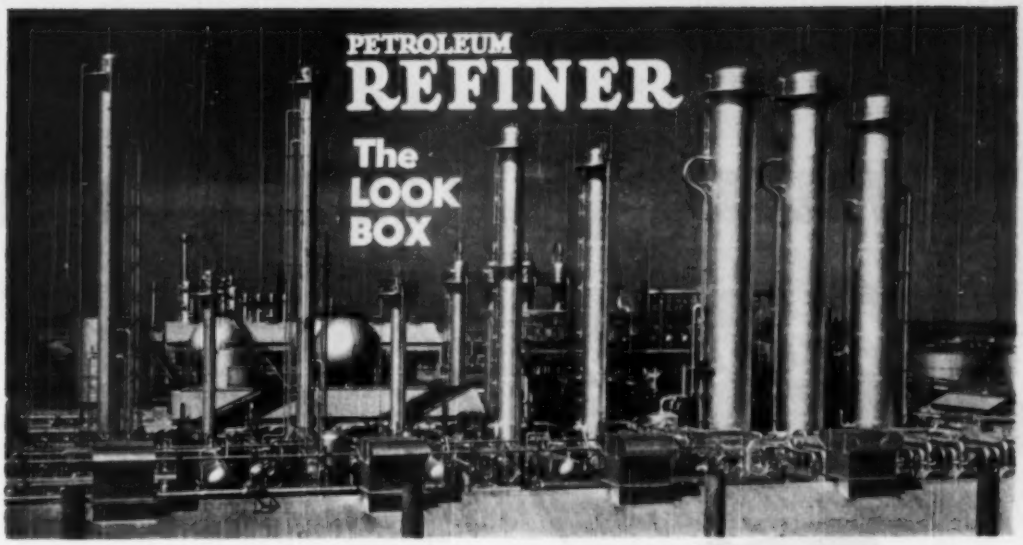

MOTORISTS and other highway users now pay more in state gasoline taxes and vehicle fees than all citizens and corporations paid in federal income and profits taxes a decade ago.

Auto Revenue Continues Climb

This startling and revealing fact is set forth in the Tax Economics Bulletin, bi-monthly publication of the American Petroleum Industries Committee, which notes that in 1940 the federal government received $2.125 billion from personal and corporate income and profits levies.

On the other hand "phenomenal increases brought the annual yield from state automotive levies to more than $2¼ billion in 1949, which compares with about $1½ billion only three years earlier and slightly less than that immediately before the war, in 1941," the Bulletin says.

"The principal reason for these impressive gains is the increased productivity of existing state gasoline taxes. Immediately before the war, for example, the states as a whole collected about $238 million annually from each cent of their motor fuel tax rates, but by 1949 this yield had increased to more than $324 million."

Estimating the revenue yield in terms of each cent of the per gallon tax rate eliminates the effect of recent 1 and 2-cent per-gallon tax increases, and shows that "this greater yield is directly attributable to the large increases that have occurred in taxable fuel consumption, which grew from about 24 billion gallons in 1941 to approximately 33 billion gallons in 1949."

The Bulletin comments that the increase in motor fuel reflects expansion of motor vehicle ownership during the decade. Figures from the Bureau of Public Roads are cited which show that since the war alone motor vehicle registrations increased by 10 million.

"The larger number of vehicles has also brought far greater receipts from state registration fees," the Bulletin continues. "This source, together with operators' licenses and other miscellaneous levies, provided . . . a gain of 62 percent compared with the 1941 prewar peak."

In addition to the state gasoline tax and vehicle fees, it is pointed out, $800 million of previously authorized federal aid is still available for state highway use and an amount considerably larger than this is now under consideration by Congress as a further authorization.

THERE is a vast difference in viewpoint between the pump or turbine manufacturer who specifies that no piping stresses be imposed on the equipment he supplies and the engineers who plan piping systems and maintain plants. The manufacturer's specification is obviously impossible in actual practice. It is nothing more or less than a subterfuge, though intended to serve a worthwhile purpose in protecting costly equipment from improper installation and abuse. It doubtless does provide the manufacturer with a certain sense of security that his equipment will be properly installed. This is a very false sense of security. Many of the operating troubles encountered with mechanical equipment in hot services can be attributed directly to stresses and distortions imposed by piping. Such factors are obscure and not easily recognized by operators when equipment does not work right. Often the

Pump Stresses

Top of Page Photo—Processing facilities of Katy Gas Cycling Plant, Katy, Texas, operated by Humble Oil & Refining Company. Daily capacity is 500 million cubic feet natural gas.

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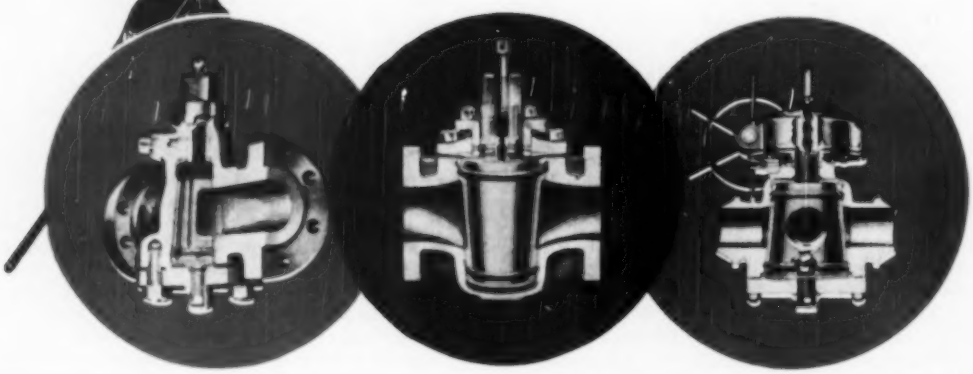

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equipment is unjustly blamed.

It is high time that this situation be corrected. All that is really needed to do this is close cooperation between the builders and users of equipment. Presently piping engineers have a choice of either completely ignoring the manufacturer's "no-stress" specification, or of trying to evaluate the load-handling abilities of equipment connections as best they can on their own. The more careful choose this last route. Procedures followed by one engineer in such work are outlined in the article "Equipment Stresses Imposed by Piping," by F. E. Wolosewick, which begins on page 89 of this issue of PETROLEUM REFINER. Methods such as these, which burden the piping man, the user, with a responsibility for strength calculations on manufactured items, are not very logical or very fair, but they are about the only satisfactory solution under present practices in specifying equipment piping connections.

Purchasers of pumps and turbines should specify the loads which they will expect equipment connections to withstand, as a basic part of any request for a price quotation. Manufacturers, for their part, should stand ready to provide realistic figures on the load capacities of piping connections on their stock items. The manufacturers in general are better qualified to judge permissible loads on equipment connections than the user.

If these problems are brought into the open and worked out by cooperative effort, real savings can be made by all. Piping systems can be simplified if their design is based upon known limits at terminal points. Many of the equipment "defects" for which manufacturers now assume responsibility can be eliminated.

Need Seen for More Oil Stocks

PROSPECTS for further gains in oil consumption of sufficient magnitude that it will be necessary to boost present near-record volumes of production and refining activities to all-time peaks in the near future, stand out in the current petroleum industry economic picture.

Higher demands for refined products were indicated by trends and prospects of normal civilian consumption before the outbreak of military hostilities in Korea. The Korean war and other expanded U. S. international commitments now presage the need during coming months for even greater amounts of oil than anticipated previously.

Although enlarged requirements for military purposes have not yet materialized to any appreciable amount, greater civilian and industrial use has caused consumption lately to exceed that of the corresponding period of 1949 and 1948, thereby creating peak levels for this season of the year. Gasoline demand recently has been at all-time peaks, and both distillate and residual fuel oil have been consumed in larger quantities than in the preceding year. Prospects for further enlargement of consuming rates have been indicated by continued heavy sales boosting the number of cars and oil burners in use to ever greater record volumes.

Military operations will need enlarged quantities of petroleum to support the Korean war, to fill storage against the possibility of a big all-out war, and for intensified training activities. War preparation activities undoubtedly also will boost industrial consumption of petroleum. Whether the U. S. is entering a big scale war now or it is to come later, there is to be immediate larger military use of petroleum.

Refinery runs have been stimulated by the recent high rate of consumption, a sharp increase carrying crude charged to stills to the greatest level in history during July. Additional gains are due in view of indicated higher consumption.

Refinery runs have climbed steadily and sharply during the past three months, averaging 5,850,000 barrels daily during the first half of July in contrast with a daily average of 5,231,000 barrels in April. The early July average also was 680,000 barrels per day above July, 1949, rates.

Crude production has logically responded to increased refinery runs, and will advance again in August. Prospects are that U. S. production of crude and condensate will approximate 5,600,000 barrels daily in August, or just 90,000 barrels short of the all-time peak reached in December, 1948. Some additions to crude stocks appear probable in August, but conditions warrant the carrying of larger inventories than now exist.

Additions to stocks of distillate and residual fuel oil have occurred recently as enlarged refinery runs increased the output of refined products. However, this is in line with normal summer operations, and it is significant that all major product inventories remain well below a year ago with the exception of gasoline. Stocks of motor fuel continue at approximately the same volume as in the corresponding period of 1949, despite record production in recent weeks.

Distillate fuel oil inventories have been growing at a faster rate than in 1949, being only 10 million barrels less than a year ago in mid-July although they had been 16 million barrels under year ago quantities at the beginning of June. This gain is highly desirable, the installation of a large number of new oil burners indicating the industry should enter the winter months with more heating oil in storage than in 1949. Meanwhile, residual fuel oil stocks have been holding steady at 25 million barrels below 1949 quantities.

Prospective high refinery runs in August may cause additional growth of refined product stocks, unless the military situation causes a sudden upsurge in demand. However, the outbreak of military hostilities indicate petroleum stocks should be increased as a national security safety measure.

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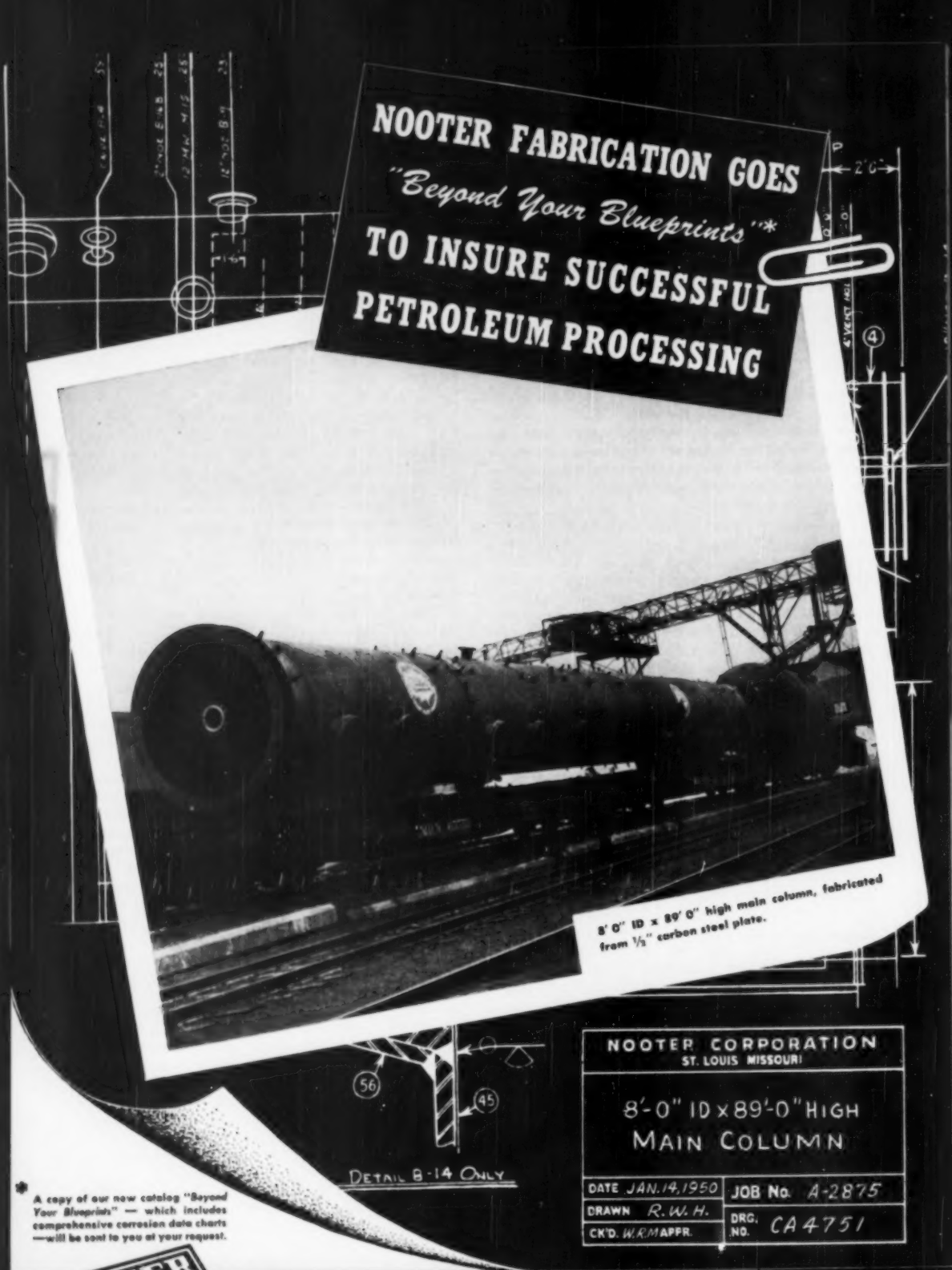

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Oil Industry Makes Effective Use of Its Capital Setup

A Pogue-Coqueron Study

PROGRESS toward stabilization in the petroleum industry "as a prelude to the improvement which became manifest in the spring of 1950" is noted in "Financial Analysis of Thirty Oil Companies for 1949" which was issued last month by The Chase National Bank, New York. The analysis, prepared by Joseph E. Pogue and Frederick G. Coqueron of the bank's petroleum department, says that in general "the petroleum industry continued to make effective and dynamic use of the mechanism of capital formation so essential for the maintenance and expansion of economic activity."

The year 1949 was termed a period of readjustment following the transition from a condition of shortage in 1947 to one of oversupply in 1948. High, though not peak, records were established in crude production, earnings and capital expenditures, it was pointed out and inventories were slightly lower, prices having undergone some reduction.

Table 1. Crude Runs to Stills of 30 Oil Companies, Segregated between Domestic and Foreign, 1948, 1949.

Area	1948	1949	Change 1949 from 1948
	Thousand Barrels Per Day		Percent
East and Gulf Coast	2,537	2,398	- 5.5
Interior	1,365	1,383	+ 1.3
California	788	789	+ 0.1
TOTAL UNITED STATES	4,690	4,570	- 2.6
Venezuela and Dutch West Indies	438	441	+ 0.7
Canada	135	153	+ 13.3
Peru and Colombia	49	56	+ 14.3
Other Countries	22	20	- 9.1
TOTAL FOREIGN	644	670	+ 4.0
GRAND TOTAL	5,334	5,240	- 1.8

Figures only include operations of companies and their consolidated subsidiaries. Associated companies, operating principally in foreign countries, refined approximately 499,000 barrels per day in 1949 distributed as follow: Middle East, 252; Europe, 194; Western Hemisphere, 50, Far East, 63; Total 499.

The investment of the petroleum industry in the U. S. was estimated at $30.2 billion and, in terms of gross assets employed, is exceeded only by agriculture, railroads and the public utilities. The industry's plant, property and equipment are carried at an estimated gross value of $23.5 billion, current assets at $6.3 billion and other assets at $0.4 billion.

Companies included in the study are Amerada Petroleum Corporation, The Atlantic Refining Company, Cities Service Company, Continental Oil Company, Gulf Oil Corporation, Houston Oil Company of Texas, Lion Oil Company, The Louisiana Land and Exploration Company, Mid-Continent Petroleum Corporation, The Ohio Oil Company, Pacific Western Oil Corporation, Phillips Petroleum Company, Plymouth Oil Company, The Pure Oil Company, Richfield Oil Corporation, Seaboard Oil Company of Delaware, Shell Oil Company, Sinclair Oil Corporation, Skelly Oil Company, Socony-Vacuum Oil Company Standard Oil Company of California, Standard Oil Company (Indiana), Standard Oil Company (New Jersey), The Standard Oil Company (Ohio), Sun Oil Company, The Texas Company, Texas Gulf Producing Company, Texas Pacific Coal and Oil Company, Tide Water Associated Oil Company, Union Oil Company of California.

Net earnings of the group were $1408 million, a decrease of 27 percent from the previous year. This result, expressed in prewar dollars, is equivalent to earnings of only $733 million of 1935-39 purchasing power.

Dividends were up by nearly 19 percent over 1948, the 30 companies having paid $564 million to stockholders or 40 percent of available earnings, the balance of the earnings having been retained in the business. Increased disbursement was made possible by the decreased outlay for plant, property and equipment. Expenditures of this kind amounted to $2.3 billion during 1949 or about 16 percent less than spent in 1948.

During 1949 domestic prices of petro-

Table 2. Estimated Gross and Net Investment in Property, Plant, and Equipment of the Petroleum Industry in the U. S., December 31, 1949.

Department	Gross Investment	Reserves	Net Investment
	Million Dollars		
Leases, Wells, and Equipment	11,750	6,350	5,400
Natural Gasoline Plants	725	275	450
Natural Gas	300	100	200
TOTAL PRODUCTION	12,775	6,725	6,050
Crude Oil Pipe Lines	1,475	750	725
Product Pipe Lines	325	125	200
Marine	1,150	450	700
Tank Cars	275	200	75
Motor Transport	75	25	50
TOTAL TRANSPORTATION	3,300	1,550	1,750
Refining	4,375	2,225	2,150
Marketing	2,750	1,100	1,650
Others	300	100	200
TOTAL-ALL DEPARTMENTS	23,500	11,700	11,800

Distribution by Department

	Gross	Net
	Percent	
Production	54.4	51.3
Transportation	14.0	14.8
Refining	18.6	18.2
Marketing	11.7	14.0
Others	1.3	1.7
TOTAL	100.0	100.0

leum products decreased 12.2 percent while crude oil prices declined 1.3 percent. Net effect of all factors resulted in a reduction of 5.7 percent in gross revenue from 1948.

The volume of crude oil processed by the domestic and foreign refineries of the 30 companies averaged 5,240,000 barrels daily in 1949, a decrease of 1.8 percent from the quantity handled in 1948. (See Table 1.) The domestic refineries ran 4,570,000 barrels per day in 1949 or 85.7 percent of the total thruput of all the refineries operating in the U. S. Production of the several companies declined 10 percent, the average being 3.4 million barrels daily for 1949.

Domestic operations contributed 2.67 million net barrels a day or about 53 percent of the total production.

Cash earnings of the group amounted to $2.7 billion in 1949, leaving $2.1 billion for other purposes after dividends. The expenditures for fixed assets and other investments aggregated $2.4 billion, requiring $0.3 billion from outside sources. Funds raised through financing and sales of assets totalled $0.7 billion. Of this amount, about $0.4 billion were added to working capital.

During the year, the group obtained funds totalling $641 million from banks, insurance companies and the public in the following proportions: 42.6 percent from insurance companies, 36.7 percent from the public, and 20.7 percent from banks.

The borrowed money and equity capital employed by the 30 companies at the close of 1949 amounted to $14.4 billion. Some 18 percent of this amount was in the form of long-term debt, a slight increase over 1948.

The $23.5 billion of gross fixed assets representing the industry's investment in property, plant and equipment are subdivided by departments as follows: production, 54.4 percent; transportation, 14.0 percent; refining, 18.6 percent; marketing, 11.7 percent; and all others, 1.3 percent. (See Table 2.)

The 1949 capital expenditures of the group totaled $2284 million, (Table 3) a decrease of 15.7 percent from 1948. Of these expenditures, $1419 or 62.1 percent, were absorbed by the rise in construction costs. This outlay was financed by funds derived from capital extinguishments of $1224 million, reinvested earnings of $844 million, and outside financing and other sources of $216 million.

Total assets of the 30 companies at the close of 1949 amounted to $16,832 million. The three main components of these assets were current assets, 31.7

• Continued on Page 70

Table 4. Gross and Net Investment in Property, Plant and Equipment of 30 Oil Companies, December 31, 1949. (By Departments and segregated domestic and foreign.)

Department	Gross			Net		
	United States	Foreign Countries	Domestic and Foreign	United States	Foreign Countries	Domestic and Foreign
	Thousand Dollars					
Leases, Wells, Equipment, and Natural Gasoline Plants	8,196,040	1,297,101	9,493,141	3,915,061	708,438	4,623,499
Natural Gas	373,932	21,251	395,183	247,137	12,474	259,611
TOTAL PRODUCTION	8,569,972	1,318,352	9,888,324	4,162,198	720,912	4,883,110
Crude Oil Pipe Lines	1,256,375	139,975	1,396,350	633,210	92,656	725,866
Product Pipe Lines	210,105	0	210,105	134,028	0	134,028
Marine	554,560	166,471	721,031	368,271	165,249	453,520
Tank Cars	39,229	289	39,622	10,790	31	10,821
Motor Transport	36,274	1,345	37,619	22,998	878	23,876
TOTAL TRANSPORTATION	2,096,643	308,080	2,404,727	1,169,291	188,214	1,347,515
Refining	3,700,900	366,001	4,155,901	1,863,400	218,167	2,081,567
Marketing	2,066,588	233,178	2,299,744	1,251,566	134,971	1,386,539
Others	431,529	13,237	434,766	279,371	4,380	283,759
TOTAL - ALL DEPARTMENTS	16,994,610	2,238,852	19,183,462	8,706,836	1,276,652	9,982,490

Distribution by Departments

Department	Gross			Net		
	United States	Foreign Countries	Domestic and Foreign	United States	Foreign Countries	Domestic and Foreign
	Percent					
Production	50.6	58.9	51.5	47.8	56.5	48.9
Transportation	12.4	13.6	12.5	13.2	15.5	13.5
Refining	22.3	16.3	21.7	21.4	17.1	20.9
Marketing	12.2	10.4	12.0	14.4	10.6	13.9
Others	2.5	0.6	2.3	3.2	0.3	2.8
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

Table 3. Gross Expenditures for Property, Plant and Equipment of 30 Oil Companies by Departments and Segregated between Domestic and Foreign, 1949.

Department	United States	Foreign Countries	Domestic and Foreign
	Thousand Dollars		
Leases, Wells, and Equipment	995,667	196,420	1,192,087
Natural Gasoline Plants	101,027	1	101,028
Crude Oil Marketing	513	0	513
Natural Gas	31,437	762	32,199
TOTAL PRODUCTION	1,128,644	197,183	1,325,827
Crude Oil Pipe Lines	122,969	14,298	137,267
Product Pipe Lines	6,387	0	6,387
Marine	69,580	7,932	77,512
Tank Cars	2,729	0	2,729
Motor Transport	5,441	380	5,821
TOTAL TRANSPORTATION	207,106	22,610	229,716
Refining	388,538	63,915	452,453
Marketing	193,083	25,133	218,216
Others	55,781	1,956	57,737
TOTAL - ALL DEPARTMENTS[1]	1,973,152	310,797	2,283,949
[1] *Includes:*			
Additions to Property Accounts	*1,797,625*	*273,813*	*2,071,438*
Intangible Development Costs Charged to Income	*24,031*	*321*	*24,352*
Dry Hole Costs Charged to Income	*127,924*	*36,663*	*164,587*
Lease Purchases Charged to Income	*832*	*0*	*832*
Other Expenditures	*22,740*	*0*	*22,740*
Total	*1,973,152*	*310,797*	*2,283,949*

By Departments, 1948 and 1949

Department	1948	1949	Distribution 1948	Distribution 1949
	Billion Dollars		Percent	
Production	1.517	1.326	56.0	58.1
Transportation	311	230	11.5	10.1
Refining	579	452	21.4	19.8
Marketing	215	218	7.9	9.5
Others	86	58	3.2	2.5
TOTAL	2.708	2.284	100.0	100.0

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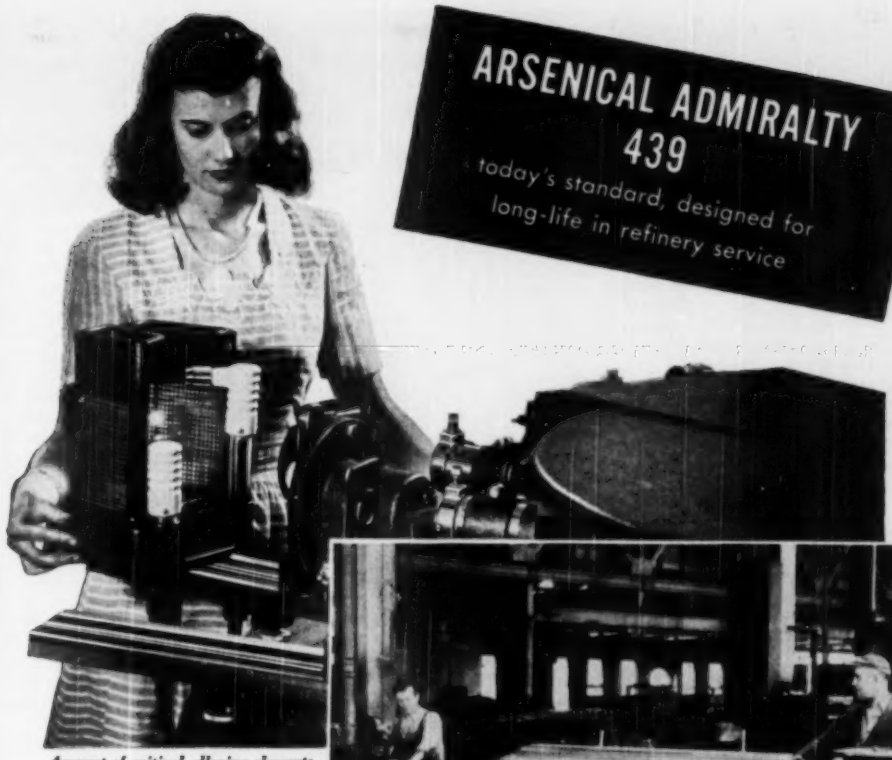

Amount of critical alloying elements is checked in the laboratory with the help of this grating-type spectograph.

Every Anaconda Condenser Tube must withstand the hydrostatic pressure test required by A.S.T.M. Specification B 111.

CONTAINING approximately 70% copper, 28.96% zinc, 1% tin and 0.04% arsenic, Arsenical Admiralty 439 is highly resistant to dezincification, general corrosion, attack by fresh, brackish or salt waters, sweet or sour crudes under pressures, velocities and temperatures normally encountered in refinery condensers and heat exchangers.

Several years of extensive research preceded the commercial production of Arsenical Admiralty Tubes which was begun in 1934. The consistently satisfactory performance of Arsenical Admiralty Tubes in crude and re-run stills, cracking and polymerization plants for the past 15 years has fully proved the effectiveness of arsenic as an inhibitor of dezincification and has fully substantiated laboratory test results.

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Peak Demand Gives Good Half Year

L. J. LOGAN
Economics Editor

DURING the first half of 1950 the petroleum industry operated on an especially satisfactory basis, after having successfully carried out in 1949 a curtailment of supply to recognize lower demand for fuel oils and to liquidate surplus stocks.

In 1949 the demand for petroleum products (except gasoline) consistently failed to equal the 1948 record. But as 1950 began, the curves were above 1948, and they have continued through mid-year to run above 1948.

For the first half of 1950, total demand for all oils averaged approximately 6,578,000 barrels per day, up 10 percent from 1949 and substantially exceeding the 6,168,000 barrels per day of the first half of 1948.

These gains have occurred in spite of lower exports. Total exports averaged 278,000 barrels daily in the first 6 months of 1950, compared with 357,000 daily in the like months of 1949 and 359,000 daily in the similar period of 1948. Domestic demand at 6,300,000 barrels daily in this year's first half was 12 percent above the 5,625,000 daily of 1949's initial half and compared with 5,809,000 daily in the like period of 1948.

Curves for motor fuel demand have reflected steady and gradually increasing consumption as the number of motor vehicles in use has continued to rise. The curve for 1949 was above that for 1948 and the one for 1950 has been above 1949. In the first half of 1950, motor fuel demand averaged approximately 2,651,000 barrels daily, up 4.8 percent from the 2,529,000 daily in first half of 1949 and comparing with 2,366,000 daily in first half 1948. Motor fuel exports averaged 72,000 barrels per day in first 6 months of 1950, down 45 percent from the 129,000 daily in 1949 and comparing with 95,000 daily in 1948's first half. Domestic consumption of motor fuel averaged about 2,579,000 barrels daily for January-June, 1950, up 7.5 percent from 2,400,000 daily in like period of 1949 and comparing with 2,271,000 daily in same months of 1948. Motor fuel stocks at mid-year 1950 were equivalent to 43 days' supply, at rate of demand in the first 6 months of the year, compared with 45 days' supply at mid-year 1949 and 43 days' at mid-year 1948. Yield of gasoline from crude has been stepped up to 43.4 percent this year from 43.3 last year and 39.5 in first half of 1948.

Distillate fuel oil demand of 1,136,000 barrels daily in first half 1950 was 19 percent above the 954,000 daily a year previously and somewhat above the 1,078,000 daily of the initial half of 1948. Exports of 31,000 daily compared with 41,000 in 1949 and 64,000 in 1948. Domestic demand of 1,105,000 daily was 21 percent above the 913,000 daily of 1949 and also above the 1,014,000 daily of 1948's first 6 months. Distillate stocks at mid-year 1950 represented 47 days' supply, compared with 68 days' supply at middle of 1949 and 43 days' supply at mid-1948. Distillate yield from crude was back up to 18.5 percent in 1950 from 17.0 percent in 1949; it had been 18.9 percent in 1948.

Residual fuel oil demand averaged about 1,573,000 barrels daily in the initial half of 1950, up 14 percent from the 1,382,000 daily of 1949 and also exceeding the 1,475,000 daily of first half 1948. Exports of 39,000 barrels daily were a little above both 1949 and 1948. Domestic demand of 1,534,000 daily was 14 percent above the 1,346,000 daily of 1949 and exceeded the 1,446,000 daily of 1948. Stocks of residual fuel oil were reduced in unusual volume in the first half of 1950, as were inventories of distillate fuel oil. Residual stocks at mid-year 1950 were equivalent to only 26 days' supply, compared with 47 days' supply held at middle of 1949 and 30 days' supply on hand at mid-1948. Yield of residual from crude was down further to 20.6 percent in 1950 from 22.6 percent in 1949 and 23.6 in first half of 1948.

Demand for lubricants averaged about 130,000 barrels daily in the first 6 months this year, up 5.7 percent from the 123,000 daily last year but under the 139,000 daily of 1948. These changes reflect domestic fluctuations mostly, as exports have been about the same as in 1949 and 1948. Lube yield of 2.3 percent from crude in 1950 is same as in 1949 but less than the 2.6 percent of 1948. Mid-year stocks are 67 days' supply, against 81 a year ago and 59 two years ago.

While demand was setting new records in the first half of this year, it was supplied to the extent of 267,000 barrels daily by withdrawals from crude and products storage. Crude stocks were drawn down at rates averaging 69,000 barrels daily and refined products by nearly 200,000 daily. In contrast, there had been additions to stocks in the first 6 months averaging 160,000 barrels daily in 1949 and 127,000 daily in 1948. Total stocks of all oils at end of June 1950 were 554,777,000 barrels, equivalent to 84 days' supply on basis of demand in the first 6 months of the year. The 634,711,000 barrels of stocks at mid-year 1949 were equal to 106 days' supply. The 523,906,000 barrels held at mid-year 1948 were 85 days' supply, about the same as the present 84 days' supply.

High for Natural Gasoline

Imports of 806,000 barrels daily in the first half of 1950 compared with 585,000 daily in first half 1949 and 476,000 daily in 1948. Crude imports of 462,000 daily compared with 411,000 in 1949 and 304,000 in 1948. Refined product imports of 344,000 daily compared with 174,000 in 1949 and 172,000 in 1948.

A new high was set for production of natural gasoline (472,000 daily against 412,000 in 1949 and 389,000 in 1948). Total crude runs to stills averaged 5,414,000 barrels per day, up 1.6 percent from the 5,330,000 daily last year but less than the 5,493,000 daily in 1948. Refinery runs of domestic crude averaged 4,949,000 daily compared with 4,923,000 in 1949 and 5,200,000 daily in 1948. Runs of foreign crude were 465,000 daily, against 407,000 in 1949.

Crude runs of 5,643,000 barrels daily in June 1950 were equivalent to 84.0 percent of the record plant capacity of 6,716,000 barrels daily available at mid-year 1950. In June of 1949 runs of 5,162,000 daily were 81.4 percent of the then existing capacity of 6,340,000 daily. In June 1948, refinery runs of 5,632,000 barrels daily were equivalent to 96.5 percent of 5,838,000 barrels capacity. At mid-year 1950 the industry was relatively well situated from the standpoint of reserve refining capacity, which amounted to over 1 million barrels daily.

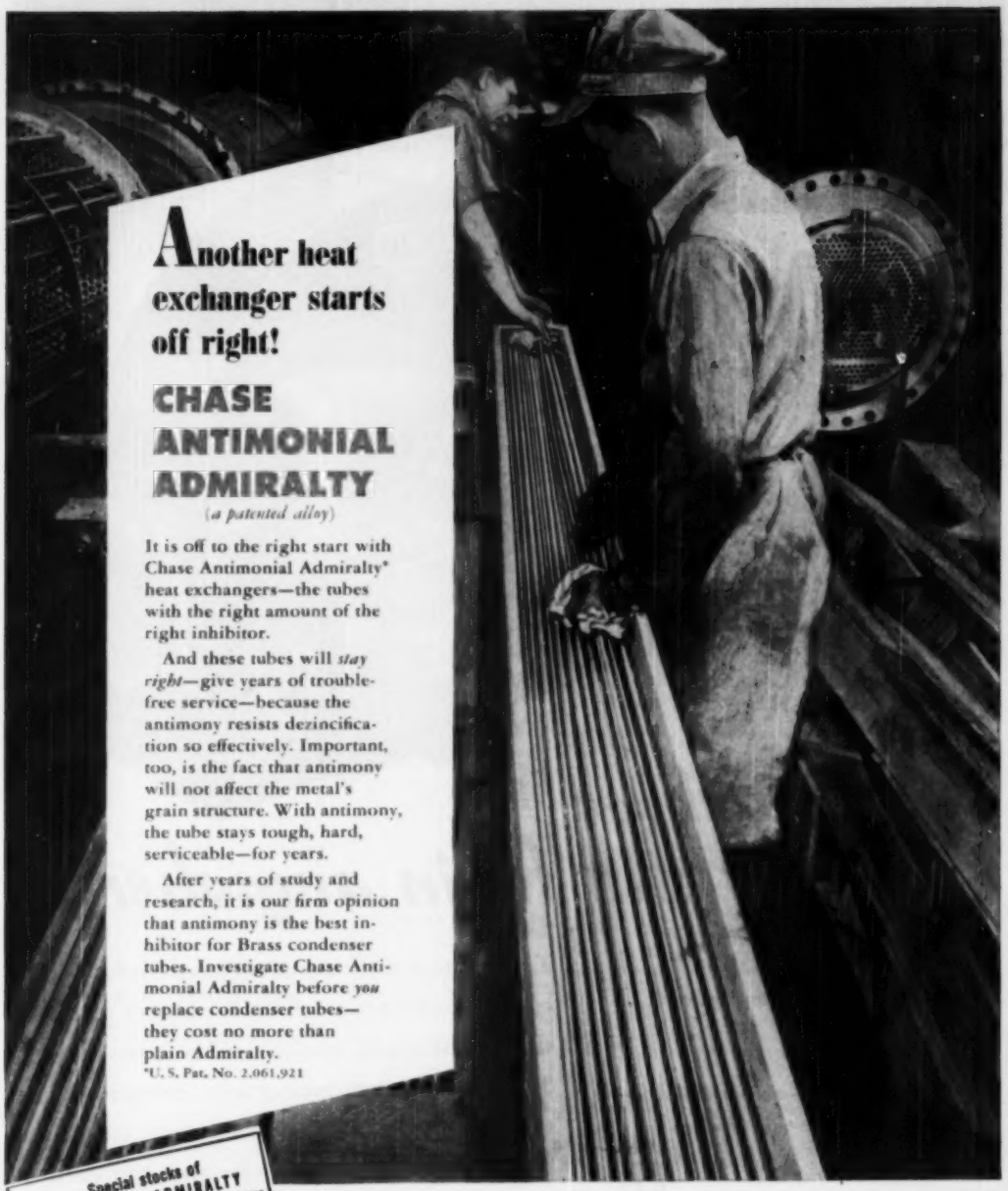
Company Finances

• CONTINUED FROM PAGE 68

percent; plant and equipment, 59 percent; investment and other assets, 11.3 percent. In 1948 the total assets were $16,032 million.

The gross investment of the group in property, plant, and equipment at the close of 1949 was $19,183 million (Table 4) against which reserves of $9201 million had been set up, leaving an indicated net value of $9982 million. This latter figure, the analysts pointed out, "is not realistic as a very large portion is stated on the basis of higher dollar purchasing power than is now prevailing. The replacement of these facilities would require an outlay of funds representing some multiple of the net carrying value."

The group increased its working capital in 1949 to $3438 million from $3060 million at the close of 1948. The increase of $378 million was accounted for principally by funds raised from borrowings. The ratio of current assets to current liabilities increased from 2.8 to 2.3 at December 31, 1948.



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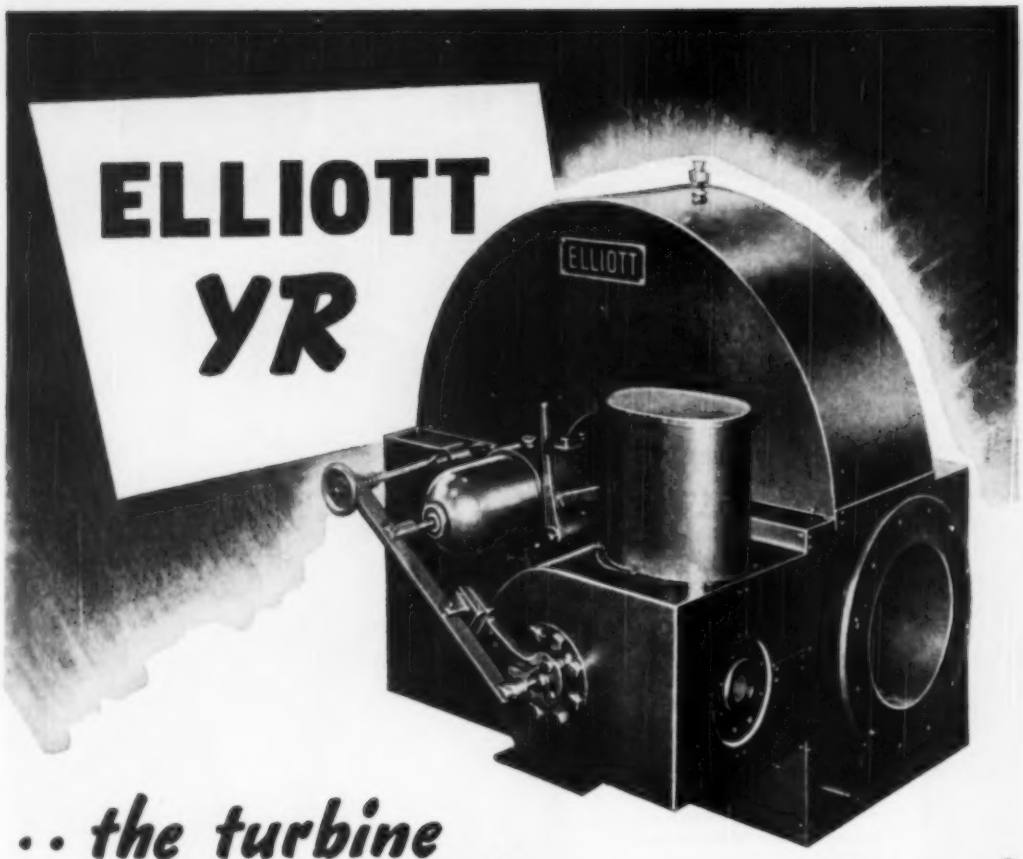

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DISTRICT OFFICES IN PRINCIPAL CITIES

Refinery and Other Plant Construction

Petroleum Refiner's Next "Box Score" Tabulation Will Appear in the October Issue

Deep Rock Oil Completing Cushing Modernization

Major units of the modernization program at Deep Rock Oil Corporation's Cushing, Okla., refinery are virtually completed with the new cat cracker on full stream. Started in 1949, the new plants and equipment expected to be in full operation by autumn, will increase the refinery's daily crude capacity from 12,000 barrels to 18,000. Besides the catalytic cracking plant, a new crude oil topping unit, research and development laboratories, office building addition, etc. are included.

The fluid cat cracker, designed by Universal Oil Products Company, Chicago and erected by Jones and Laughlin Supply Corporation, Tulsa, includes a feed preparation unit, cracking reactor-regenerator, fractionating section and gas concentration unit. It will be able to process more than 5000 barrels of crude cracking stock daily.

The control unit, engineered by Deep Rock and UOP, will enclose graphic control boards and gauges for all of the cracking plant units.

The topping unit, in addition to providing charge for the vis-breaker, was designed for the fractionating of naphthas, distillate fuels, and other straight run products. Included in this unit also is new Petreco electric desalting equipment.

Auxiliary units include a new gasoline blending plant, 200,000 barrels of additional storage tankage of the newest type, new loading racks, one-third expansion of the boiler plant, new cooling towers, etc.

Sinclair Completes LP-Gas Unit at Marcus Hook Plant

A new 1100-barrel-per-day unit designed and built by Sinclair Refining Company for liquefied propane gas production at its Marcus Hook, Pa., refinery has gone on stream, and product is being shipped by tank car and truck to New York, New Jersey, Pennsylvania, New England, and Canada. Prior to that unit's completion, LP-gas was shipped from the Mid-Continent.

Pan Am Research Building Completed at Texas City

Construction of a new research building at Texas City, for Pan American Refining Corporation has been completed by The H. K. Ferguson Company. The one-story structure provides an additional 10,000 square feet of floor space for research uses at the Texas City refinery.

Conoco Completes Three Gas Plants in Texas

Continental Oil Company has recently completed three gas plants in Texas at a total cost of nearly $5 million, the plants being the expanded Rincon natural gasoline plant, near McAllen; a natural gasoline plant in the Todd (Deep) field, Crockett County, West Texas; and a gas compressor plant in the Slick-Wilcox field, near Kenedy.

Continental, in partnership with Rice Institute and others, has completed an extensive enlargement program at Rincon where the unit has been increased from 13 to 20 million cubic feet of gas. Daily production capacity is approximately 6000 gallons of liquid petroleum gas and approximately 25,000 gallons of gasoline. The plant returns approximately 8.5 million cubic feet of gas to the reservoirs daily.

The Rincon plant is a part of a 42-home community that includes an airport, hard-surfaced streets, landscaped parkways and residential areas, and a company-owned and operated school bus for the exclusive use of school children of the community. (See photo below.)

The Todd unit has a daily capacity of 60,000 gallons and is handling all of the gas produced in the Todd (Deep) field.

The Slick-Wilcox compressor plant has a rated capacity of 10.8 million cubic feet of gas daily. Gas from the plant is utilized for gas-lift operations in the field and is sold to United Gas Company.

Huge Cat Cracker Planned By Gulf at Port Arthur

Contract for the construction of a 60,000-barrel-per-day Fluid catalytic cracking unit was awarded by Gulf Oil Corporation in early August to The M. W. Kellogg Company. The plant will be erected at the company's refinery at Port Arthur, Texas, and the anticipated output will be approximately 20 percent greater than that of any similar installation currently in operation or under construction by any other firm.

The new cat cracker is scheduled for completion during the late summer or early fall of 1951. Cost, with auxiliary equipment, will be approximately $8 million.

Work on foundations will begin during the next several weeks. Much of the fabrication will be done on the job.

While the unit, according to officials, will be the world's largest, total output of the refinery will not be increased materially above the present 230,000 barrels per day. It will enable the company, however, to increase its production of higher octane gasolines for both military and civilian use.

Completion of the plant at Port Arthur will follow by just two years installation of 20,000-barrel-per-day units at both Toledo and Cincinnati and will raise Gulf's total of cat crackers to eight.

Superior to Build Plant In Colorado County

Superior Oil Company has announced that contract will be let shortly for the construction of a natural gasoline plant in the Ramsey field of Colorado County, Texas. Capacity of the plant will be 60 million cubic feet daily with an estimated cost of $1,500,000. The 25-acre site of the plant, about 4½ miles north

Below is shown a general view of the Rincon (Texas) Natural Gasoline plant operated by Continental Oil Company. It is one of three plants recently put into operation by Conoco. See item above.

of Eagle Lake, Texas, has been leased to the company for fifty years.

Main units of the plant will be for dehydration, absorption, and distillation. The combined products of the plant will be transported through existing pipe lines to Superior's Lake Creek cycling plant in Montgomery County for fractionation into final products.

Construction of the plant is scheduled to start during January with completion expected sometime in June.

Sunray Is Rebuilding Refinery at Santa Maria

Sunray Oil Corporation will rebuild and modernize its 7500-barrel-per-day Santa Maria, Calif., refinery, portions of which were destroyed by fire in late June. The program should be completed early this fall.

Engineering studies are being made to determine the extent of improvements required to make the plant "one of the most modern petroleum asphalt plants on the West Coast." The natural gasoline plant section of the refinery was not appreciably damaged by the fire, but the topping plant along with tanks, pumps, and miscellaneous equipment will be rebuilt. The refinery vis-breaker unit which was partly destroyed will be replaced along with necessary auxiliary equipment.

Premier Petroleum Plans Fort Worth Platformer

Premier Petroleum Company is planning to construct a 1500-barrel-per-day platforming unit at its Fort Worth, Texas, refinery. Design and construction of the facilities will be under the supervision of Universal Oil Products Company with construction to begin as soon as possible.

Petco Builds Cat Cracker At Its Chicago Refinery

Petco Corporation, a division of Great Lakes Refining Company, will increase production of high octane gasoline by 55 percent at its Chicago refinery with the completion, October 1, of a new $2 million Houdry cat cracking unit. This unit will boost the refinery's output by 5000 barrels a day. Presently the plant processes about 9000 barrels per day.

California Research Is Building Livermore Shop

With a figure of $450,669, Dinwiddie Construction Company, San Francisco, with $450,000 was low bidder for construction of a steel frame building near Livermore for California Research & Development Company. Actual construction started in July. The building, to be covered with protective metal siding, will be 220 feet long and 160 feet wide.

California Research & Development is a new subsidiary of California Research Corporation, formed to direct a new research project for the U. S. Atomic Energy Commission at the site of the former Naval Air Station near Livermore.

Socony-Vacuum Plans New East Chicago Cracker

Socony-Vacuum Oil Company, Inc., will build a new Thermofor catalytic cracking unit at its refinery in East Chicago, Ind., providing a total of eight such units under construction or to be completed during 1950. The construction contract has been let to C. F. Braun and Company.

The new TCC units with moving-bed catalysts will replace existing fixed-bed units and will provide an increase of 50 percent over the present 10,000 barrels per day capacity of each present unit for a total thruput of 120,000 barrels daily of automotive and aviation gasoline and other products.

Fixed-bed catalytic cracking units are being converted to TCC at company refineries in Buffalo, N. Y., Beaumont, Texas, Brooklyn, Trenton, Mich., and Augusta, Kan.

Construction of two more TCC units of simplified design by The Standard Oil Company (Ohio) at its refinery in Cleveland, Ohio, also has been licensed by Socony-Vacuum.

Scurry County Gaso Plant To Be Operated by Sunray

A new gasoline plant to be operated by Sunray Oil Corporation for 35 operators and casinghead gas owners cooperating in the area, has been announced for Scurry County, Texas. Construction is to begin within the next three months with completion set for the spring of 1951. Location of the plant will be on the Von Roeder farm, tract 20, section 40, Kirkland and Fields survey, Scurry County, Texas.

Proposed facilities will process approximately 67 million cubic feet per day. A capacity in excess of 450,000 gallons per day of liquefied products includes propane, butane, natural gasoline and other allied products. Engineering analysis indicates an extraction of 7 and 8 gallons of liquid products per mcf. of gas processed.

Recently placed in operation were high-pressure gas gathering lines by which the conservation of flare gas in the field will be sold to gas pipe lines taking deliveries within the field.

Approximately 35,000 producing acres in the North Snyder, Kelley-Canyon, and Diamond "M" fields are involved in the construction and operating contract covering development of the project. The enterprise will be under the general supervision of H. W. Manley, recently named manager of Sunray's gas and gasoline department. Superintendent of the construction project will be L. G. Rogers, superintendent of the manufacturing operations section. E. J. Mills, formerly superintendent of the Benton, La., gasoline plant, will be field project superintendent.

Vacuum Flash Unit Built By California Standard

A vacuum flashing unit, 80 feet high with a maximum diameter of 27 feet will be constructed at the Richmond, Calif., refinery of Standard Oil Company of California. Contractor is The M. W. Kellogg Company. The unit, scheduled for completion in May, 1951, will be able to charge 55,000 barrels of reduced crude a day and will also process some heavy, so-called "non-refinable" crudes. Asphalt, the other major product from the flasher, will be charged to visbreakers to produce high quality fuel oil and gasoline. The flasher is being designed to provide approximately 30,000 barrels of feed each for the existing cat cracker at Richmond, which is scheduled for revamping during the modernization.

Negotiations Are Underway For New Palestine Refinery

Israeli government officials are negotiating with American oil interests for the construction of a new oil refinery in Haifa, Palestine. The Anglo-American Committee on Palestine, who visited Israel on behalf of the American independent oil operators has announced that Israel is considering the contract.

The Haifa refinery of Consolidated Refineries, Ltd., a plant with present capacity of about 85,000 barrels a day, has been closed for nearly two years.

Union Oil Is Building Washington Asphalt Plant

Union Oil Company of California is constructing at Edmonds, Wash., a million dollar asphalt refinery, having an annual capacity of 65,000 tons of paving asphalts, road oils and cutbacks. It is set for completion in June, 1951. Construction of the refinery, including blending tankage and shipping facilities, will be handled by Bechtel Corporation. California crude will be shipped by tanker.

Mathieson Building Plant For Chlorine, Caustic Soda

Chemical Plants Division of Blaw-Knox Company has been awarded a contract by Mathieson Hydrocarbon Chemical Corporation of Baltimore, Md., for the engineering and procurement of a large new chlorine and caustic soda plant to be located at Saltville, Va. Expected to go into operation in 1951, this new chlorine production unit has design based on the Mathieson mercury cell process which produces chlorine and rayon grade caustic soda of 50 percent concentration directly from the cells.

Construction Underway On Tennessee Gas Plant

Tennessee Gas Transmission Company's $12 million plant at Greensburg, Ky., (see May, 1950, PR, page 67) for the extraction and recovery of liquid hydrocarbons from natural gas is in the early stages of construction. Initially, the plant is being built to process in excess of 600 million cubic feet of natural gas daily from which will be obtained approximately 400,000 gallons daily of liquid hydrocarbons consisting of ethane, propane, butane, and natural gasoline.

Pure Oil Research Lab Nearing Completion

New research and development laboratories of The Pure Oil Company at Crystal Lake, Ill., are nearing completion. Recently concluded at the lab was a five-day refinery technical symposium which included sessions on 28 subjects ranging from department organization and operating standards to discussions of sour crudes, control of circulating water, thermo and fluid catalytic cracking. A. E. Harnsberger, technical operating manager was chairman.

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1. **98% entrainment efficiency in crude oil distillation.**
2. **Operation at full capacity without contamination.**
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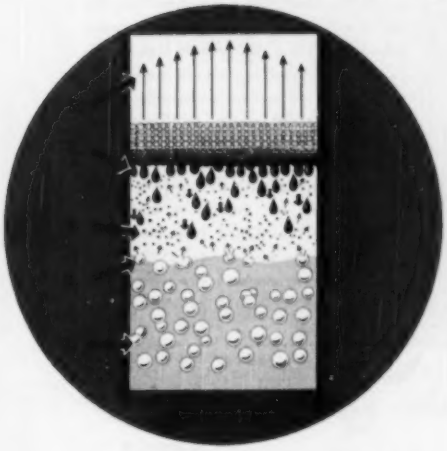

HOW A METEX MIST ELIMINATOR WORKS

Bubbles of gas, passing through a liquid (1), burst on emerging (2) and form a fine spray which rises entrained in the gas flow (3). As this mixture passes through the Mist Eliminator, the entrained liquid is "wiped out" and retained by the extensive wire area until it forms drops sufficiently large to fall back through the rising flow (4). The gas continues on (5), entirely freed from entrainment.

In Metex Mist Eliminators is found the practical application of impingement filtration to the purification problems involved in liquid-gas separation processes. (See illustration) Baffles, centrifugal chambers or additional head room above the disengaging surface are not required, nor is it necessary to slow down operations to secure separation of the entrained liquids.

WHAT IS A MIST ELIMINATOR

A Metex Mist Eliminator is a pad consisting of multiple layers of wire mesh, which is *knitted*—not woven —from corrosion resistant metal. Each layer is diagonally crimped, with crimps running at right angles in successive layers of mesh.

To insure accurate fitting and ease in handling and installation, each Mist Eliminator is assembled, prior to shipment, from long narrow strips of the desired thickness. These are cut to fit the shape and dimensions of the equipment in which the pad is to be installed. Sections are readily passed through man holes and assembled within the equipment at the desired location, and across the line of flow.

WHY METEX MIST ELIMINATORS ARE EFFECTIVE

1. Their unusually high free volume (often 98%) imposes minimum resistance to flow of gases.
2. The multiplicity of wires makes "straight line" passage of gases impossible.
3. Entrained liquid is "wiped out" on these wires, to coalesce and fall back through rising vapors.
4. Maximum resistance to corrosion is obtained by selection of the metal or alloy used for wires.
5. Easily installed or replaced in new or existing equipment.

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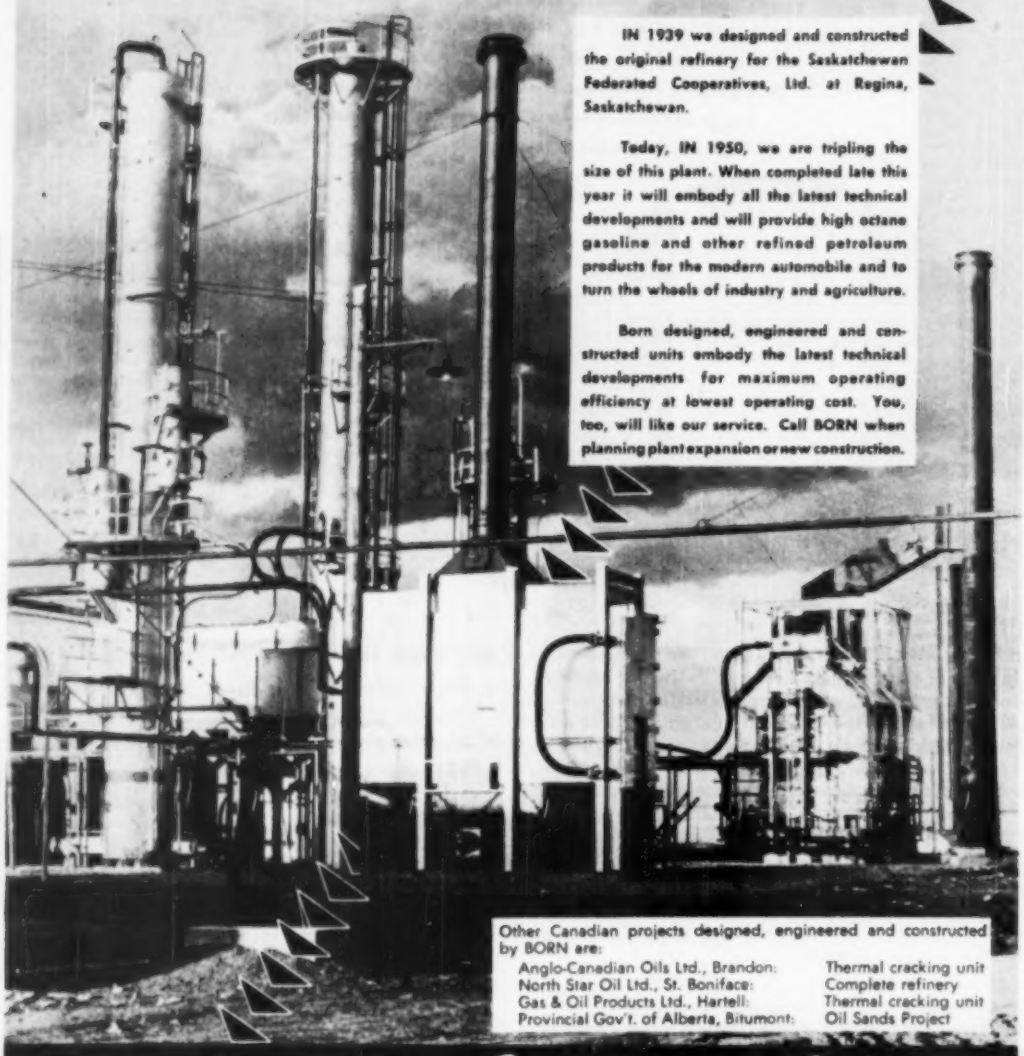

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Today, IN 1950, we are tripling the size of this plant. When completed late this year it will embody all the latest technical developments and will provide high octane gasoline and other refined petroleum products for the modern automobile and to turn the wheels of industry and agriculture.

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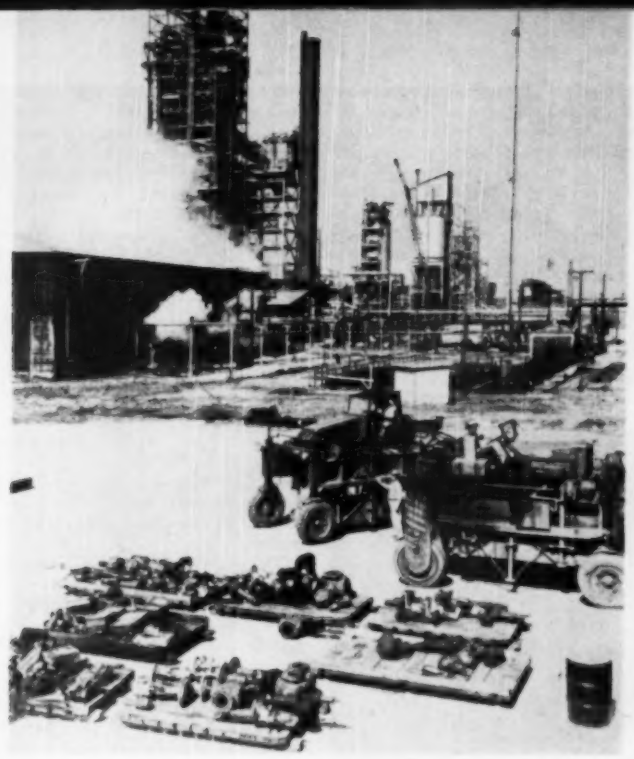


CONTROL VALVES do not always receive the attention and care given other equipment of similar importance to the operation of a process unit; yet they are expected to perform satisfactorily under extremes of processing conditions, weather, dirt, and vibration. In recent years, however, refineries have set up programs of preventive maintenance and extensive repair facilities. As a result, the service life and operation of control valves has been extended and improved.

The methods and equipment described and illustrated in this article are among the latest and most efficient in use today.

Maintenance and Repair Of Refinery Control Valves

W. H. FORTNEY, Humble Oil & Refining Company, Baytown, Texas,
and
C. C. PRYOR, Associate Editor

REGARDLESS of the cost of automatic control instrument, successful operation of a control system depends as much on the operation of the control valves as upon the accuracy and sensitivity of the instruments. In other words, the control system cannot be better than the control valves.

Control valves must be both rugged and sensitive. They must respond to the smallest changes in output pressure from the control instruments; yet they must withstand operating temperatures and pressures, vibration, shock, corrosion, erosion, and other conditions of operation.

The performance obtained from a valve depends upon selection, installation, and finally—maintenance. Actually, maintenance begins on the manufacturer's drawing board, where the proper features are incorporated into the valve and suitable materials are designated. Maintenance must be considered when the engineer who designs the process specifies the valves. Maintenance must be considered also when the valve is being installed. It should not be subjected to piping stresses, vibration, and other undesirable environ-

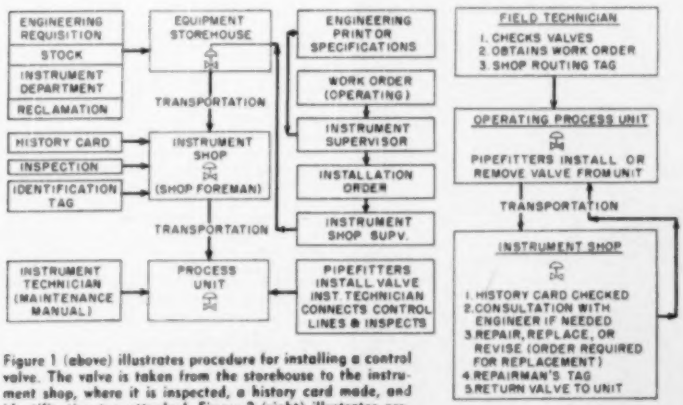


Figure 1 (above) illustrates procedure for installing a control valve. The valve is taken from the storehouse to the instrument shop, where it is inspected, a history card made, and identification tag attached. Figure 2 (right) illustrates procedure for repair or replacement of a control valve from the process unit to the instrument shop.

Top-of-Page Photo

Pallet carriers or "straddle buggies" haul equipment to and from process units, Baytown Refinery of Humble Oil & Refining Company. These pallets loads of valves are from the No. 1 fluid catalytic cracking unit, which is in the background. The pallets will be conveyed into the shop by the electrically operated pallet carrier and the straddle buggies.

ments. Whatever the solutions reached for these designs, application, and installation problems, the valve is finally turned over to the maintenance man.

As part of the instrument maintenance program of the Baytown refinery of Humble Oil & Refining Company, inspection and repair of control valves has been developed into a routine procedure. The instrument department is divided into three main groups: field, shop, and engineering and clerical.

The refinery is divided into three field zones, each in charge of an instrument supervisor. Each field supervisor has from six to eight instrument "technicians." Each technician has an area assigned to him, which may include one large unit or several small units, depending upon the number and concentration of instruments. Each technician is responsible for all instruments and control valves in his area.

The engineering and clerical section, as the name implies, handles all of the departmental paper work, including routine clerical and design work on the instrument ends—(orifice plates, etc.), meter runs, special inner valve designs, and field installation sketches. The engineers are a staff group, who work with the field supervisors or the shop supervisor and assist them in their problems.

The shop organization is divided into three major sections:

1) Machine Tool Section. This section is fully equipped with lathes, milling machines, and other machine tools, sufficient to make the shop independent of the main Machine Shop. Parts or even complete instrument units can be manufactured if necessary.

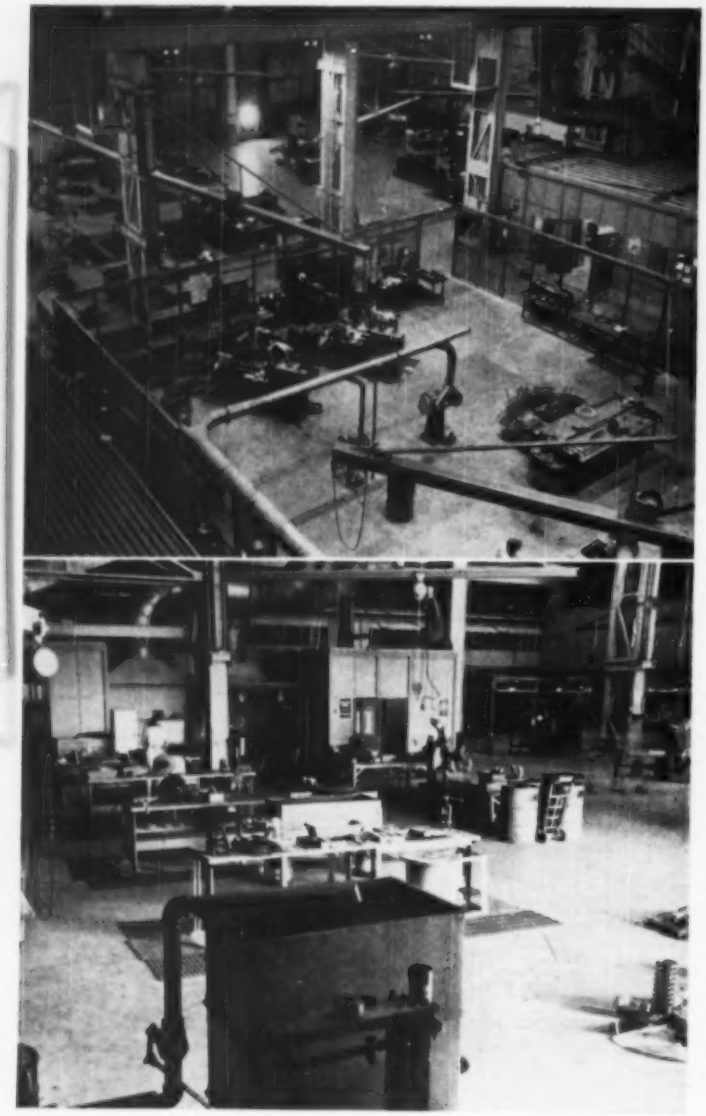
2) Floor and Bench Section. Here the main work of repair and calibration is done. This section is equipped with jib cranes, numerous jigs and fixtures, calibrating equipment, power tools and hand tools.

3) Electrical Section. This section is provided with the tools and testing and calibrating equipment to handle practically every type of electrical or electronic instrument repair and calibration.

The procedure for installation of a control valve is shown in Figure 1. Although it may appear complicated, the procedure is relatively simple. While certain records are necessary for proper functioning of the department, the procedure has been streamlined to prevent duplication or excessive paper work. As a matter of fact, however, additional records are kept by some field technicians for their personal use in maintaining the valves assigned to them.

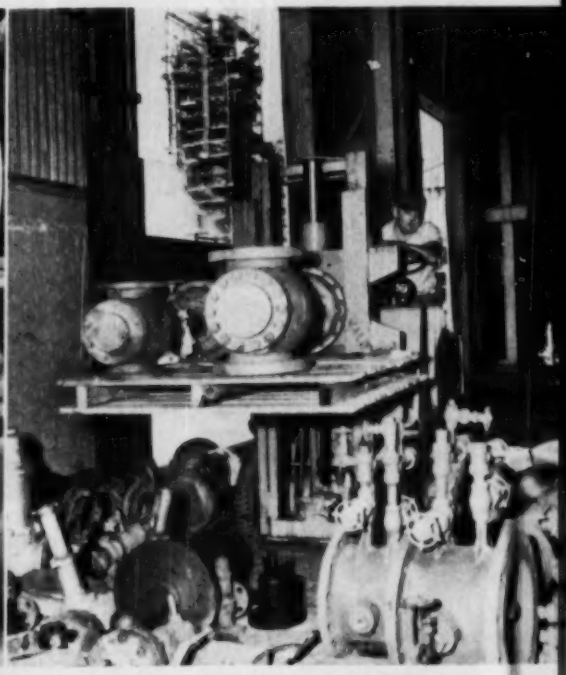
As a starting point in describing a valve installation, it is assumed that the valve to be installed is in the storehouse. It may have arrived at the storehouse by one of several routes: 1) by engineering requisition for a new job; 2) by instrument department requisition; 3) by return from reclamation stock or from a discontinued unit, and 4) it might be a routine stock item.

Authority to install the valve may come from the engineering drawings



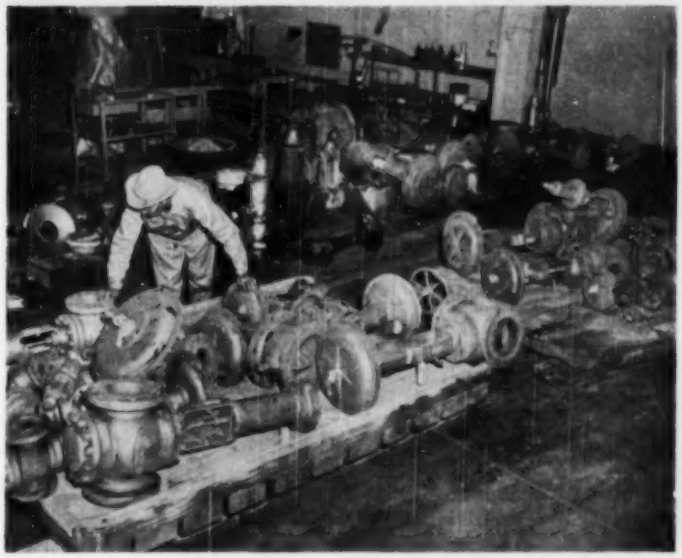
Left, above—In the foreground is a part of the machine room facilities of the instrument shop. Left background—relief valve repair and test racks. Center background-control valve displacement meter and other heavy equipment repair area. Right background—enclosure for shop supervisor, orifice meter and gauge repair, pyrometer and electronic instruments calibration and repair. Ducts carry discharge from paint spray booths. Each area is equipped with jib crane with electrically operated hoists. Wide lanes make each area of the shop readily accessible. Equipment and materials are distributed with a motor-driven hydraulically operated fork lift truck and electrically operated pallet carrier.

Left, below—Heavy and light control valve section. Deadweight tester in foreground. In this area control valves, displacement meters and liquid level instruments are inspected and repaired. In left background is paint spray booths and shop supervisor's office. At right is entrance to machine room of the shop.



Above, left—H. A. Garner, instrument technician, repacking control valve in fluid catalytic cracking unit No. 2. Inset shows lubrication of valve. Both operations are part of routine field maintenance.

Above, right—Repairman O. S. McCullough, operating fork lift truck, prepares to distribute a pallet of heavy valves that have been sandblasted to work locations. The No. 1 fluid catalytic cracking unit is visible in the background.



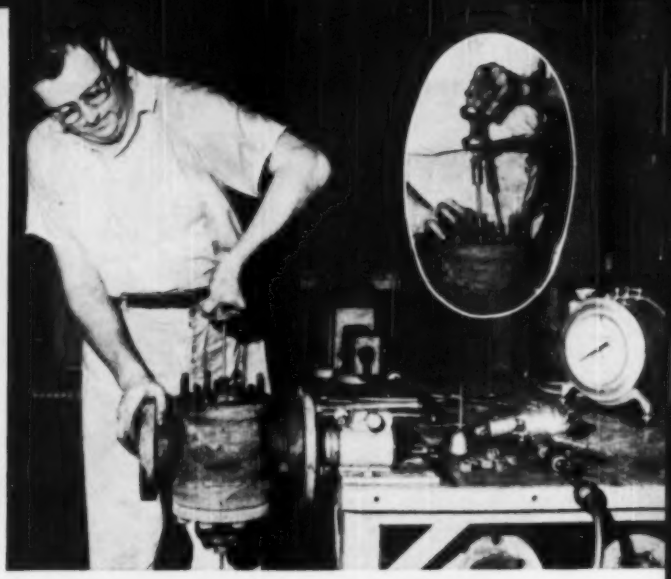
Two pallet loads of valves that have been returned to the shop from sandblasting. Loaded pallets in background contains equipment sent in from process units for repair. T. O. Newman, working shop foreman, makes preliminary inspection of valves to determine routing for repair work. Before sandblasting valves, stems are wrapped and air connections are plugged for protection. Sandblasters are instructed not to sandblast interior of valves.

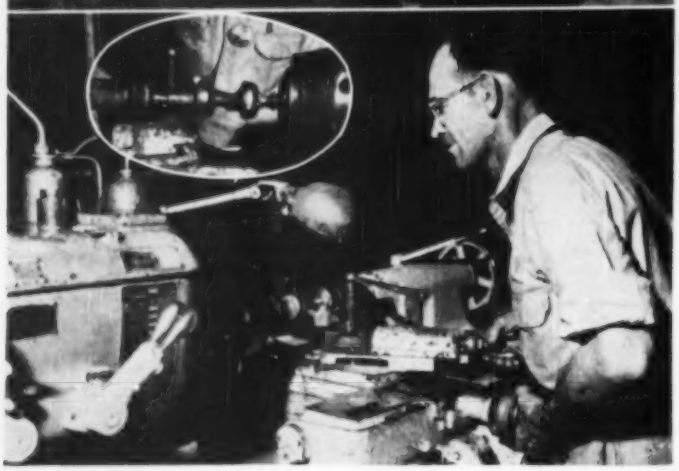
on a new job or from an operator's work request in the field.

The instrument field supervisor originates an installation or alteration order. This order has space for all pertinent data. It is sent to the shop supervisor and the valve is ordered from stock by the shop clerk. The valve arrives from the storehouse by truck and is rechecked by the shop clerk. After inspection of the valve by the floor and bench foreman, to see that the features are correct, the clerk makes out a history card containing all the data on the installation order, and any other information that the shop foreman may desire to place on the record.

The valve is then given a thorough check by a repairman in the shop, after which it is ready for transportation to the field. The shop check includes an inspection of the valve itself, packing, lubricant, and the addition of a metal nameplate, on the spring barrel, which describes the location and service of the valve. This nameplate saves much time in identifying valves when a large number of valves are in the shop for repairs. A separate metal tag is also attached, which shows the initials of the mechanic who approved the valve for service and the date on which it was checked.

The installation order is returned to the originating supervisor, who arranges for transportation of the valve





Above, left—Repairman McCullough removing superstructure from valve body using electrically operated hoist on jib crane. Pneumatic "nut-runners" or wrenches are used throughout the shop where applicable. Tools such as these do much to speed work. Valve holding jig permits valve body to be rotated and locked at any quarter position.

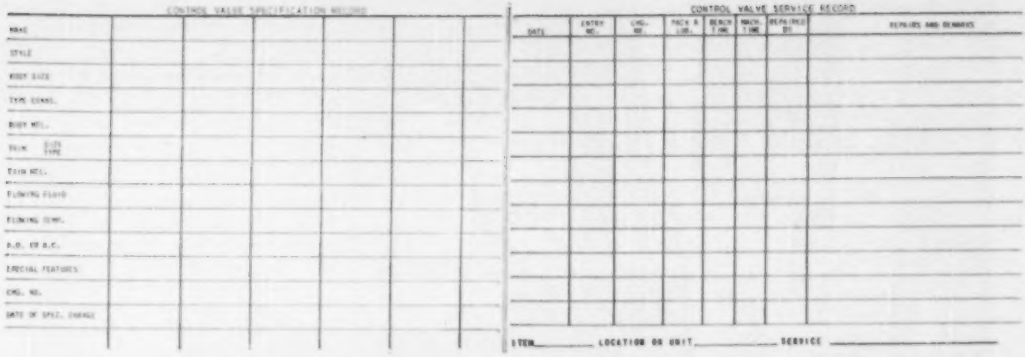
Above right—Repairman McCullough lapping in refaced plug in valve body.

to the field. At the unit, it is installed by the pipefitters, and the airline connected by the instrument field technician. The technician is further responsible for checking the action of the valve, and checking for leaks in the control line. The valve is now ready for operation.

Each field technician has a maintenance manual in book form in which are listed all the instruments in his area. These instruments are listed by their service and by unit, and also by frequency of maintenance. Thus a separate page will be devoted to listing instruments which must be checked twice a week; another once a week, etc. The new valve takes its place on this list by its controlling instrument. Field maintenance consists of checking the packing for leaks and regular lu-

Top left—Heavy control valve undergoing repair. Newman and B. H. Jones, repairman, discuss repairs to a butterfly valve. Background shows repairmen, L. W. Pohler and W. J. Reineke, at work on valves and regulators. McCullough is operating the fork lift truck. Equipment at right is kidney float holding device.

Bottom left—C. G. Lindstrom, machine operator, refacing a control valve plug in a machine room lathe. Both seats on the plug must be matched properly with those in the valve body. When a repairman cannot grind in a valve quickly at the bench, the plug is sent to the machine room for refacing. Corroded or eroded plugs are built up with weld metal, then turned down to their original dimensions.



CONTROL VALVE SPECIFICATION RECORD

MAKE						
STYLE						
BODY SIZE						
TYPE CONN.						
BODY MTL.						
TRIM (FLOW TYPE)						
TRIM MTL.						
FLOWING FLUID						
FLOWING TEMP.						
P.D. OR D.C.						
SPECIAL FEATURES						
ENG. NO.						
DATE OF SPEC. CHANGE						

CONTROL VALVE SERVICE RECORD

DATE	ENTRY NO.	LOC. NO.	PACK & LUB.	BENCH TIME	MACH. TIME	REPAIRED BY	REPAIRS AND REMARKS

ITEM_____ LOCATION OR UNIT_____ SERVICE _____

A history card for each control valve is maintained by the shop clerk. All repairs, part changes, and duty are recorded throughout the life of the valve. When a valve is brought to the shop, its history card is checked by the shop foreman. One side (left, above) of the card contains the specification record and the reverse (shown right, above) the service record of the control valve. Actual card size is 5 x 8 inches.

brication; periodic inspections for "travel," and operating position (amount of valve opening).

Replacement of a valve in operation on a unit may be necessary for a number of reasons. The valve may be too large or too small. If it is required to operate almost wide open, it is too small, or if the plug constantly rides the seat, it is too large. The design of the valve body or plug, or the materials used, may not be suitable for the service required. On the other hand, trouble with the valve may be caused by vibration fatigue from adjacent piping. Corrosion and erosion quite often are cause for replacement.

In cases of severe corrosion, the instrument engineer consults the plant metallurgist on a substitute material. The shop has found that erosive slurries of sand, catalyst, and clays, may require trim of heat treated tool steel or stainless steel, and a different valve body, designed for such service. Clay slurries may cut conventional carbon steel valves out in 18 to 24 hours. The venturi, or free flow (single plug) type control valve, with trim of heat treated tool steel may last 12 weeks in similar service.

Valve Repair

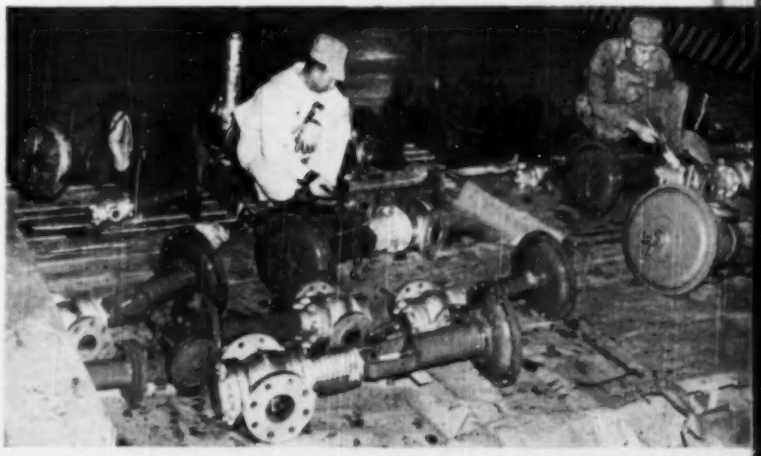
The discussion heretofore has been concerned with the installation and replacement procedures. There are other ways by which a control valve is sent to the instrument shop—the most common of which is the routine turnaround. The technician, before a turnaround, prepares a list of valves which should be taken to the shop for overhaul, or for checking and repairing. These valves are removed from the unit by the pipefitters, loaded on pallets, and transported to the shop by straddle-buggy.

Upon arrival at the shop, the valves are checked on the pallet by both the shop foreman and the shop clerk. The clerk makes a list of the valves received, pulls the history cards on each from the file, and places them on the shop foreman's desk. The foreman inspects the valves while they are still on the pallets and designates those which should be taken to the cleaning vats. Those which have been in acid or corrosive chemical service are given a thorough washing regardless of their apparent condition. All such valves should have an additional tag, which calls attention to the dangerous chemicals they might contain. This tag also may state the nature of trouble experienced with valve. Cleaning may consist of merely washing down with hot water, or the use of dipping vats containing cleaning solution. However, most of the valves received at the shop are not cleaned, especially if they are to be returned to the unit in a short time. When time permits, the valves are sent to the sandblast shop. After thorough sandblasting, they are returned to the shop, where they are overhauled and subsequently painted. Most routine turnarounds do not permit time for complete painting.

The shop foreman from his inspection determines which valves appear to need the greatest amount of repair. These valves are worked on first. Each valve is assigned to a repairman until the available manpower is assigned. The valves are picked up the fork truck, which is equipped with a lifting attachment and placed in the jigs, shown in the photographs. They are then dismantled for internal inspection. When it is apparent that new parts or extensive repairing, such as welding, are required, the parts are ordered, or the parts are sent to the welding shop, and the mechanic starts to work on another valve.

For speed and ease in dismantling

Repaired valves being painted before being returned to a unit.



B. C. Norris operating the fork lift truck, which has hook lift attachment across forks for hoisting and moving individual valves. This valve is being moved to outgoing pallet for return to a unit after being repaired and painted. Superstructure is painted red and the valve body aluminum.

and assembling, pneumatic nut runners and impact wrenches are used in the shop. If machine work is required for the repair, it is handled by the instrument department machine shop. For example, a plug may require trimming to seat properly. If the repairman cannot grind in the plug easily and quickly, a machinist turns it to fit, which saves time for the repairman, and speeds the job.

Sometimes the spring barrel of a valve is broken. The broken pieces may be assembled by the repairman in a mandrel, the edges of the break bevel ground, and the assembly sent to the welding shop, where it is welded. The use of the mandrel prevents misalignment during welding. Final alignment is made in the lathe.

Diaphragms that are leaking, or that show signs of deterioration, are replaced by the repairman.

By this time the shop foreman has had time to examine the history cards on the valves in the shop. When he finds a valve that appears to be a *regular visitor* to the shop, it is time to make an investigation. The foreman checks with the supervisor and the engineer, calling their attention to the fact that the valve seems to require excessive maintenance and repair. Here is one point where the record system receives full justification. The engineer will check the conditions shown on the service card against those actually existing in the operation, and the supervisor checks with the area technician for his comments. Perhaps a different style of valve body should be used, or a different material used in the trim. In some cases a different type of packing or lubricant is needed. In extreme cases where the life of the valve between repairs is very short, the engineer will discuss the problem with the company metallurgist, and between them decide upon the proper material for the part in question—valve body or trim. While this matter is being settled, the repairman is working on another valve which may need only routine checking and grinding.

Installation or alteration order issued by the instrument field supervisor. The order contains all data pertinent to the control valve and its installation. Actual card size is 5½ x 8½ inches.

INSTRUMENT VALVE
INSTALLATION OR ALTERATION

TAG _____ DATE _____

LOCATION _____

_____ PRESENT _____ NEW _____

SERVICE _____

MAKE _____

STYLE _____

SIZE _____

BODY _____

TRIM _____

PACKING _____

LUBRICANT _____

REMARKS _____

_____

_____

JOB NO. _____ REQ. NO. _____

INSTALLED BY _____

DATE _____

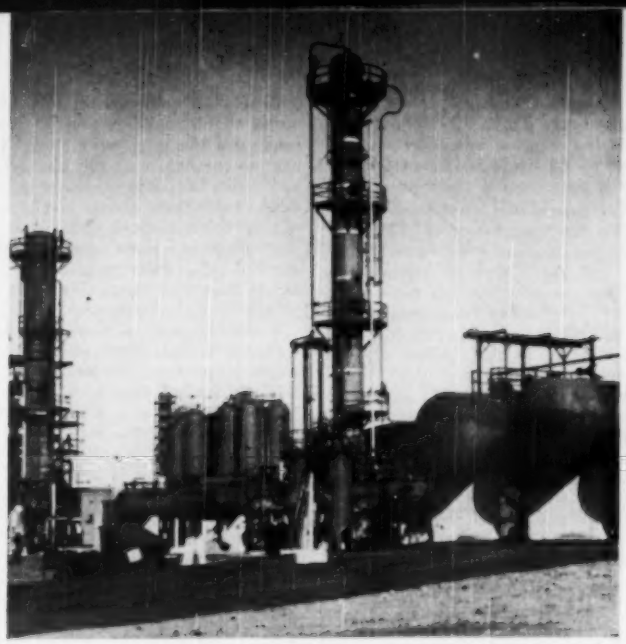
Shop routine calls for an inspection of the valve seat plug, regrinding, checking of the guides for alignment and possible sticking, checking of the packing gland, the diaphragm, valve stem and the entire superstructure. Alignment from top to bottom is extremely important.

The mandrel for mounting two-inch and larger valves slides into the holding jig and permits rotation of the valve body. Thus, it is possible for the mechanic to remove the bonnet and blind head and to regrind the valve plug without changing the holding piece. A connection in the end of the mandrel permits him to connect an air line to test for leakage with both bonnet and blind head removed. Upon reassembly, the diaphragm is tested for leakage and the valve is tested throughout its travel, usually from three to fifteen pounds gauge on the diaphragm, and open and close on the valve plug. The stem must move freely and without friction throughout its entire travel.

The repairman may overhaul two or three valves while the decision is being reached on the valve he first dismantled. If it is a simple replacement of parts, then the parts are ordered from stock. If a special material is indicated, it may be necessary to make a complete trim in the machine room. The shop is equipped to manufacture all types of valve trim.

The final checks include valve body gaskets, packing, lubricant, and stem travel. The valves are then placed on pallets in the outgoing area, ready for transportation back to the unit. If time permits, the valve is painted.

During a general inspection and overhaul of the unit, all control valves are brought into the shop, sandblasted, overhauled, and painted and returned to the unit. This overhaul in the shop is also noted on the history card of each valve.



Propane Recovery Unit with Supply Storage in Background.

Propane Mixture Purified, Sweetened and Dehydrated In One Continuous Operation

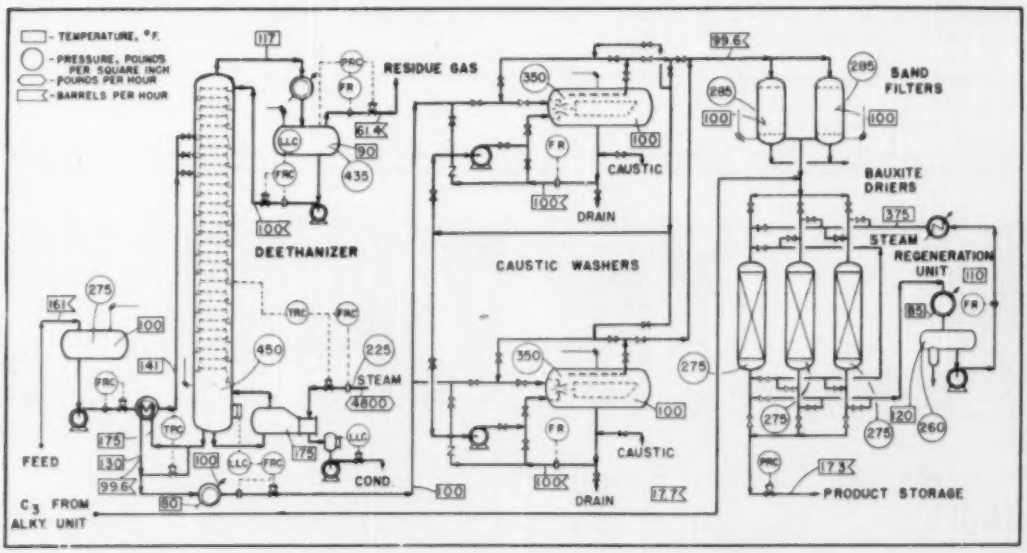
A PROPANE purification plant that extracts the ethane and methane from composite charge, sweetens and dehydrates the finished product in one continuous straight-line operation is being run with a thruput of almost 4300 barrels per day.

Raw debutanized propane is obtained from several sources and collected in adequate pressure vessels from which it is fed continuously to a 6-foot x 34-foot feed surge tank at a pressure of 275 psig. Of the total charge to the propane recovery unit,

PROPANE, a material discarded to the residue gas streams of many refinery processes, often finds a good market of its own. Where such markets exist it is sometimes practical to install special processing equipment for propane manufacture. In one such installation, described here, the propane was available from several process streams and in several degrees of purity, though each stream has been debutanized. A single unit provides fractionation, desulfurization, and dehydration to make a finished commercial propane. The cost of the special unit can readily be justified by its considerable output of a salable product.

Flow Sheet for Propane Refinery Purification Plant.

Feed Pump capacity is 122 gpm., 1285-foot head, and @ .445 specific gravity. The Feed Bottoms exchanger duty is 685,000 Btu. per hour, A = 500 square feet, and K = 415. Bottoms after cooler-duty, 352,000 Btu. per hour; K = 37, A = 500 square feet, and water 35 gpm. Overhead Condensers — 3 million Btu. per hour duty, K = 55, A = 412 square feet, and water 300 gpm. Reboiler — 4,260,000 Btu. per hour duty, U = 7500 Btu. per square foot; A = 570 square feet. Regeneration Heater — 1 million Btu. per hour duty, K = 80, and A = 120 square feet.



161 barrels per hour consists of sour material containing both hydrogen sulfide and a slight trace of water in solution. The remaining 17.7 barrels per hour is primarily ethane free and contains no hydrogen sulfide, but shows a trace of moisture, which is removed along with the major portion of the charge.

The main feed to the propane recovery unit is picked up by two pumps operating in parallel under recording flow control and charged to the deethanizing column. This feed has an average temperature of 100° F. which is increased to 141° F. by a shell-and-tube feed-to-bottoms heat exchanger. The charge may enter the deethanizer through any of three feed nozzles placed above 21st, 23rd, and 25th bubble trays. (Trays numbered from the base to the top.) This column has an inside diameter of 5 feet, a total height of 72 feet, and contains 30 bubble trays spaced on 2-foot centers.

The feed temperature is controlled by the quantity of column bottoms passed through the feed-to-bottoms exchanger.

The operating pressure on the column is 450 psig., and the reboiler temperature 175° F. Reboiler heat requirements are supplied by 225-pound steam from nearby steam generators, at a rate of 4800 pounds per hour. Steam is admitted to the reboiler through a recording flow controller having its thermowell set into the side of the column between the 10th and 11th bubble trays. Experimental column operation indicates the most effective control of fractionation is obtained with the control point between these bubble trays. The 10th tray is controlled for a temperature of 175° F. The propane bottoms stream contains an extremely small percentage of ethane and no trace of methane. Steam condensate from the reboiler is pumped from a water accumulator fitted with a liquid level controller, so that a water seal is maintained.

The top of the deethanizer is operated at a temperature of 117° F. by pumping overhead condensate back to the top tray. Overhead vapors from the column flow through two sets of water-cooled reflux condensers in parallel. Three hundred gallons per minute of water at 80° F. gives a reflux accumulator temperature of 90° F. Accumulator pressure is 435 psig. Residue product is released through a control valve into the plant fuel system. The normal quantity of reflux 100 barrels per hour. Liquid volume reflux ratio is .621:1 to feed, and ratio to residue gas discard is 1.466:1.

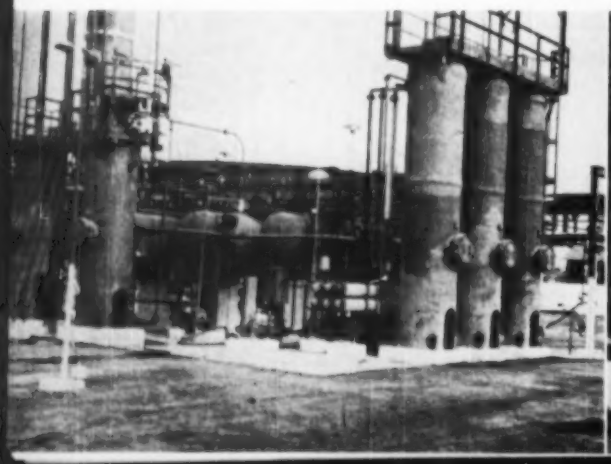
From the charge of 161 barrels per hour to the fractionator, there is recovered as 99 plus propane, a volume of 99.6 barrels per hour which contains no methane or ethane, but has a trace of hydrogen sulfide. These hot bottoms flow through the feed to bottoms exchanger to a product cooler which reduces the temperature to 100° F.

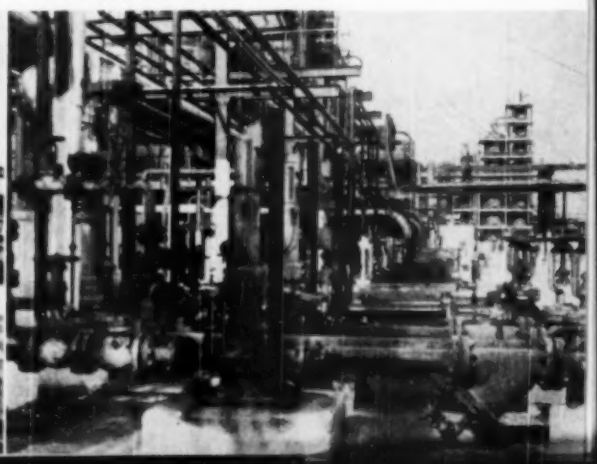
A recording flow controller reset by a liquid level instrument permits the stream to pass to caustic washing equipment. To sweeten the propane, two horizontal vessels are installed to operate at 350 psig. These vessels are piped with manifolds to permit operation in parallel or as a single unit. Caustic in these contactors is intimately mixed with the propane by recirculating both caustic and product at a rate of 100 barrels per hour each. Caustic is withdrawn from the bottom side of the vessels, and propane from the transfer line leaving the top of the contactors. Freshly fractionated propane flows into the vessels through a nozzle slightly above the center of the head, and the circulating pump discharges through a similar connection just below the center of the intake head. Inside these vessels is a venturi mixing nozzle through which both the fresh propane and the caustic-propane mixture pass under high velocity to obtain maximum contact between the product and the treating solution.

Sweetened propane flows from each contactor to sand filters which remove traces of treating solution. These filters are vertical vessels, 4 feet x 10 feet and operate at a pressure of 285 psig., either singly or in parallel. At the line leading from the base of the filters, a connection is installed which permits sweet fractionated propane from other sources to comingle with the fractionated product from the propane recovery unit. The combined stream, amounting to 117.3 barrels per hour is led to the dehydration section of the unit. This section contains three 4-foot x 18-foot vertical vessels filled with prepared bauxite which serves to dry the product before storage. Three horizontal storage vessels are used.

The bed of bauxite is regenerated with hot treated propane pumped at a rate of 13 barrels per hour. This propane flows from a 4-foot x 16-foot feed tank through a steam heated vaporizer to raise its temperature to 375° F. Hot propane vapors and water vapors are condensed in a shell-and-tube cooler. Water is drained from an accumulator boot, while the liquid propane is recirculated through the heater and bauxite bed until tests indicate that all moisture has been removed. Pumps which handle the propane are vertical units, with multi-vane impellers set in a well for flooded suction.

Below, left: Treating Section of Propane Recovery Unit with Bauxite Dryers at Right and Sand Filters at Extreme Left. Steam Heating Units at Left Side of Dryers for Regeneration of Bauxite. *Below, right*: Vertical Multi-Stage Centrifugal Pumps which Circulate and Transfer Propane in Process at Propane Recovery Unit.





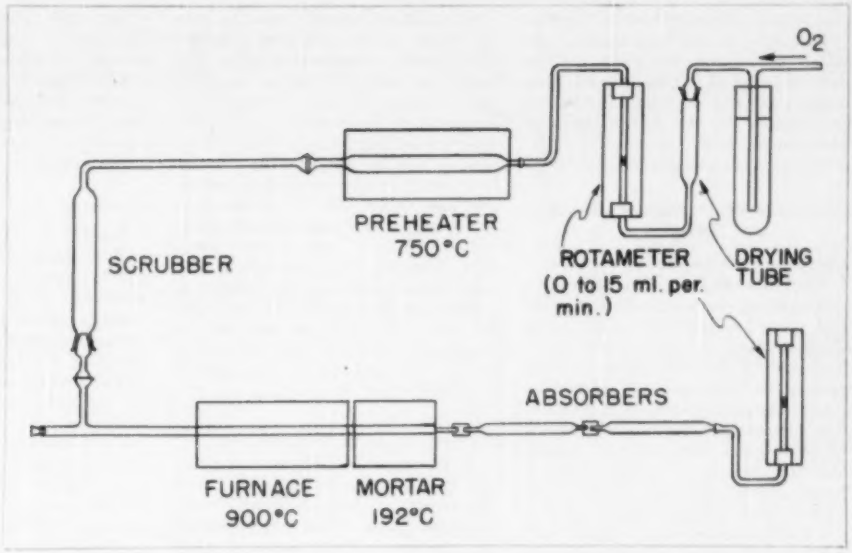


Figure 1. Diagram of Microcombustion Apparatus for Carbon and Hydrogen.

Reduced-Scale Methods for Micro and Semimicro Organic and Inorganic Analysis

PART 1

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Shell Development Company, Emeryville, Calif.

IN PETROLEUM research laboratories, the use of reduced-scale analytical methods is desirable or necessary for several reasons. The main application of such methods is the analysis of certain types of samples which are inherently too limited in amount for macroanalysis; e.g., engine or corrosion deposits aggregating only a few milligrams. In many such instances, other classical microprocedures, i.e., gamma procedures, are applicable but they are often tedious, require very careful sample preparation, and/or necessitate highly specialized apparatus and technique. Reduced-scale methods are also useful for some samples sufficient in amount for macroanalysis because they afford obvious advantages in the analysis of precious (valuable) materials, explosive compounds, and substances which corrode or deplete expensive macroequipment. In addition they sometimes offer a means of obtaining useful analytical data on small residues remaining after unsuccessful applications of macromethods. Thus, in many cases, they are a suitable means of obtaining an analytical result on small samples with more-or-less conventional apparatus and technique. Mr. Parks, whose present address is Stanford Research Institute, Stanford, Calif., originally presented this topic at the Symposium on Micro Chemistry and the Petroleum Industry held at the ACS meeting, March, 1949, San Francisco.

REDUCED-SCALE analytical methods are generally adaptations of conventional macromethods which have been scaled-down to utilize small-sized samples (3 to 50 mg.). They are not confined to semimicro samples (10 to 50 mg.) because they can sometimes utilize the amount of sample (less than 10 mg.) generally used with micromethods. In the main, their precision and accuracy approach that of the equivalent macromethods. In this connection, it is generally necessary to carry through a blank and make corrections for all reagents used in an analysis.

This presentation covers reduced-scale methods found useful in these laboratories for the determination of organic and inorganic constituents. Some of them are based on methods described in the literature; brief elaboration of detail is given concerning such methods for the sake of clarity and comparison with existing variations in other laboratories. The remaining cases represent new methods which, for that reason, are given in detail.

In the organic field, methods are described for the determination of carbon, hydrogen, nitrogen, and sulfur by combustion means and of nitrogen by Kjeldahl digestion. There is also a discussion of methods of determining organic functional groups including acidity, basicity, saponification number, and carbonyl value; detailed procedures are given for the determina-

tion of ester value and hydroxyl group.

Pertaining to inorganic analysis, detailed procedures are given for the determination of silica, aluminum, nickel, tin, and calcium. Procedures are outlined for the determination of phosphorus, lead, copper, iron, zinc, silver, sodium, and potassium.

Methods of Organic Elemental Analysis

Carbon and Hydrogen

The microdetermination of carbon and hydrogen is carried out in a modified Pregl apparatus,[23] a schematic diagram of which is shown in Figure 1. The rates of flow of oxygen into the combustion tube and exit gases from it are indicated by sensitive rotometers. The combustion tube is constructed of 10-mm. (o.d.) Vycor glass; a quartz side-arm, bearing a spherical joint, is sealed on the entrance end to permit connection to the scrubber system following the preheater. To permit the analysis of samples of unknown composition, a universal tube filling is used which includes a section of lead peroxide maintained at a temperature of 192 ± 1°C. The sample (3 to 10 mg.) and the absorbers are weighed on an Ainsworth Type FDJ projected beam microbalance. The absorber for water is filled with Dehydrite; that for carbon dioxide is filled with Ascarite.

Nitrogen by Dumas Combustion

The diagram of the apparatus for the microdetermination of nitrogen by the Dumas method is shown in Figure 2. Provision is made for reverse purging with carbon dioxide during introduction of the sample to the tube. The sample (3 to 10 mg.) is not covered with oxidizing material, such as copper oxide, but is pyrolyzed in a metered stream of carbon dioxide. The remaining residue is burned in a metered stream of pure (electrolytic) oxygen. A motor-driven, platinum-wound traveling furnace (1000°C), is used to heat the sample. The nitrogen is collected in an ungraduated azotometer tube (filled with 30 percent caustic solution) and subsequently, it is transferred to a buret system where it is accurately measured over a saturated brine solution. The buret is so constructed that volumes of less than 0.3 ml. are measured with an accuracy of 0.001 ml., and those from 0.3 to 1.0 ml. with an accuracy of 0.005 ml.

Nitrogen by Kjeldahl Digestion

In the microdetermination of nitrogen by Kjeldahl, the acid digestion of the sample is done in small 30-ml. Kjeldahl flasks which are connected to a glass manifold by means of spherical joints. The fumes are removed from the manifold by sucking a slow stream of air through by means of a water aspirator. The distillation of the ammonia is made in all-glass, Kirk-type steam distillation assembly.[10]

Halogens and Sulfur

For microdetermination of halogens and sulfur, the sample (3 to 10 mg.) is slowly burned in a stream of oxygen passing through an empty quartz tube (8 mm. i.d.), a portion of which is maintained at 800 ± 25° C. by an electric furnace. The strong acid gases are stripped from the oxygen stream by means of a special absorber containing sodium carbonate solution (Figure 3). The halide ions are determined by amperometric or potentiometric titration with standard silver nitrate solution; the sulfate ion is precipitated and weighed as barium sulfate. In the latter method a constant correction is applied in order to achieve satisfactory accuracy.

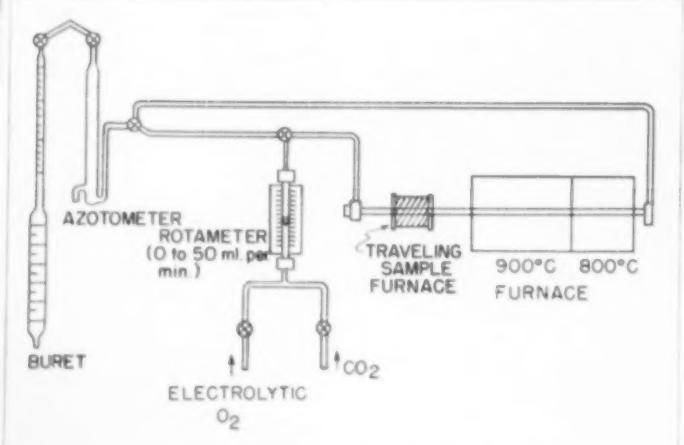
Discussion

While the above combustion methods are chiefly useful in the analysis of samples limited to 100 mg. or less total weight, they are also of value in the analysis of samples which are not so limited in size. For example, their use makes possible the analysis of peroxy compounds and dinitrophenylhydrazones without serious, damaging explosions generally attendant with macromethods; probably, the small sample does not allow the potential hazard to develop before the sample portion is consumed. Another example is the preferred use of microcombustion procedures for carbon, hydrogen, and nitrogen in the analysis of materials rich in phosphorus, halogens, and/or metals; these elements give rise to difficulty in the macroapplications by severe corrosion and rapid depletion of the tube fillings. The equivalent microapplications are only slightly affected by these elements because of the small sample used.

Like the similar macro version, the micro-Kjeldahl method is strictly applicable to only certain types of nitrogen compounds (e.g., amines and nitriles). However, for such materials, it is preferred to the more universal Dumas method for the analysis of groups of similar samples and for samples low in nitrogen.

The details of the above methods, unless otherwise stated, are similar to those found in the well-known work of Pregl.[23]

Figure 2. Diagram of Microcombustion Apparatus for Nitrogen by Dumas Method.



Methods of Organic Functional Group Analysis

Acidity and Basicity

For the determination of acidity and basicity, the sample (30 to 50 mg.) is dissolved in 10 ml. of a 1:1 mixture of benzene and isopropyl alcohol and titrated potentiometrically with 0.02 N standard alcoholic base or acid,[1,13] using glass and calomel pencil-type electrodes in a special cylindrical cell,[14] shown in Figure 4, and measuring the cell potential with a suitable electronic voltmeter.[21] The titration is made from a 10 ml. buret graduated in 0.05 ml. divisions. By means of the titration curve, differentiation is made between strong and weak acids and strong and weak bases. Correction is

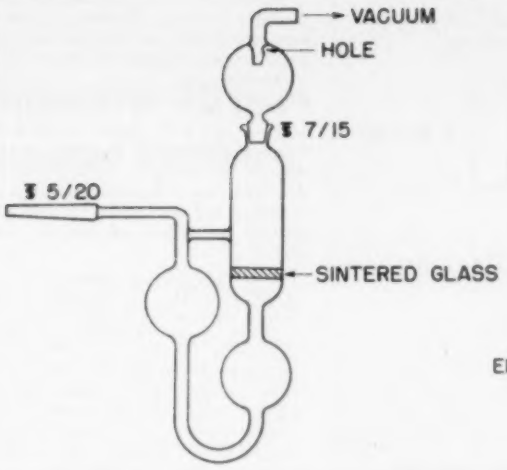


Figure 3. Absorber Used in Microdetermination of Halogens and Sulfur.

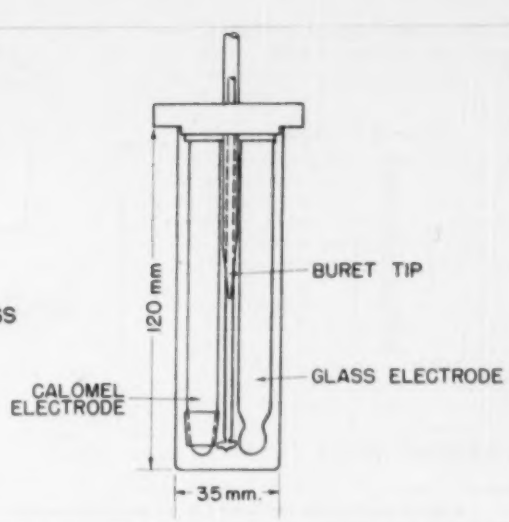


Figure 4. Cell for Micropotentiometric Titration of Small Volumes of Solution.

made for the acidity or basicity found in a corresponding blank test.

Saponification Number

In the determination of saponification numbers, the sample (30 to 50 mg.) is refluxed in a medium consisting of 5 ml. of benzene and 5 ml. of 0.1 N standard alcoholic base,[2,13] using a reflux apparatus with the water-cooled, snug-fitting immersion condenser illustrated in Figure 5. Without removal from the reflux cell, the excess base remaining after the reaction is titrated potentiometrically as above with 0.1 N standard alcoholic acid. From the titration curve, differentiation is made between strong and weak acids formed during saponification. A blank test is made under identical conditions and the difference in titration used for calculation of total and strong acid saponification number.

A modification of the Foulke and Schneider method[9] is used for the microdetermination of ester values on organic compounds; normal alcoholic potassium hydroxide is substituted for the diethylene glycol-potassium hydroxide reagent. The reflux tube, with stopcock, and the heating block are shown in Figure 6. The detailed procedure is as follows:

Weigh 100 to 150 mg. of isopropyl alcohol-potassium hydroxide reagent into reflux tube. Add 5 to 10 mg. of sample, immediately close with top, and weigh. Place in cool heating block and slowly heat with microburner. When the temperature reaches 60 to 70° C. open the stopcock momentarily to equalize the pressure. Continue heating to 130° C. and heat for 2 minutes at this temperature. Remove the reflux tube, allow to cool to room temperature, and wash contents into a 10-ml. Erlenmeyer flask with a minimum amount of water (2 ml. or less). Titrate with 0.02 N acid, using phenolphthalein as indicator, to determine the amount of hydroxide consumed. Correct for saponifiable chloride and for acidity present in the original sample.

Hydroxyl Group

The microdetermination of hydroxyl group is carried out by a modification of the method of Peterson, Hedberg, and Christensen.[22] The alcohols are reacted with acetic anhydride-pyridine mixture in hermetically sealed microtubes. Details of the procedure follow:

By means of a hypodermic needle, introduce 2 to 10 mg. of sample into a weighed reaction tube (3 mm. i.d., 6 cm. long, soft glass). Centrifuge, weigh, add

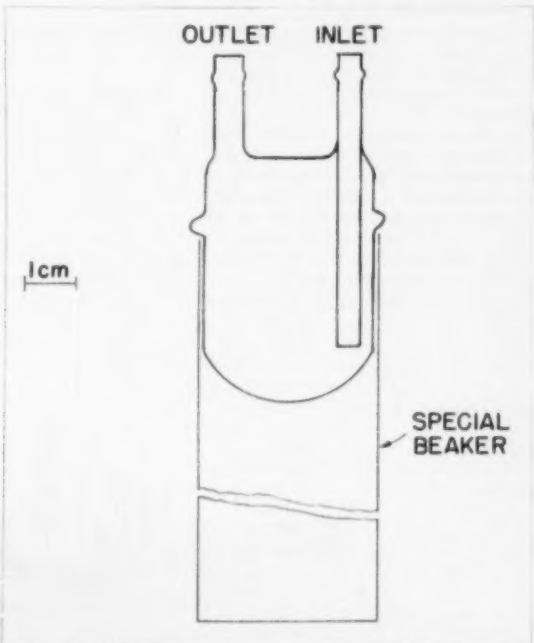


Figure 5. Water-Cooled Immersion Condenser for Microsaponification Unit.

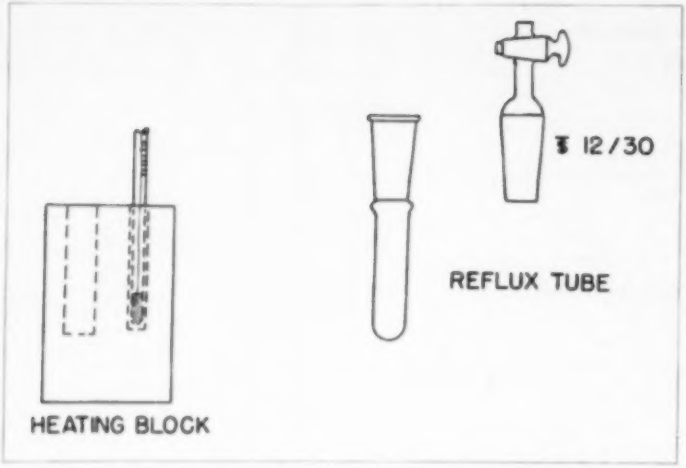


Figure 6. Heating Block and Reflux Tube for Microdetermination of Ester Value.

50 to 60 mg. of the acetic-anhydride-pyridine mixture, and centrifuge again. Place the tube in an ice mixture and seal with a fine flame. Weigh the sealed tube, shake well, and set aside for 24 hours. Place the tube in a 125-ml. Erlenmeyer flask containing about 10 ml. of carbon dioxide-free distilled water, crush with a stirring rod, and titrate unused acid with standard sodium hydroxide to the phenolphthalein end point. Titrate a known weight of the reaction mixture in a similar manner with the standard sodium hydroxide. Adjust this figure to apply to the amount of reaction mixture used per sample, and obtain by difference the amount of acid consumed.

Carbonyl Group

The reduced-scale determination of the carbonyl group on water-soluble compounds is carried out using the aqueous hydroxylamine method of Marasco.[15] Water insoluble compounds, or compounds of either type in water-immiscible solvents, are usually analyzed by the alcoholic hydroxylamine method of Smith and Bryant.[25] In either case, the sample (10 to 50 mg.) is added to a known amount of hydroxylamine hydrochloride solution (heating, if necessary) and the solution is titrated with 0.01 N standard base to determine the hydrochloric acid formed equivalent to the carbonyl of the sample.

Discussion

As shown in Table 1, the acetic anhydride-pyridine method (above) gives good results in the determination of hydroxy group in various alcohols. Similar results are obtained by the ester and carbonyl methods. The functional group methods described are applicable only to typical, reactive compounds and are not always dependable in analyzing unknown materials. However, the recovery obtained is good enough to be of definite value in most cases. These methods are particularly useful in affording confirmatory information on samples that have been almost depleted in other diagnostic tests.

TABLE 1

Recovery of Known Amounts of Alcohol by the Modified Acetic Anhydride-Pyridine Micro-Procedure for Hydroxyl Group

ALCOHOL	Hydroxyl, Percent	
	Theory	Found
Isopentanol	19.3	19.3, 19.1, 19.2
n-Butanol	22.7	22.0, 21.8
Isobutanol	22.7	21.8, 21.4
Ethylene glycol monomethyl ether	22.4	22.1, 22.4
Ethylene glycol monoethyl ether	18.9	18.8, 18.9

End of Part I. The second and concluding part will appear in an early issue of PETROLEUM REFINER. *It will discuss reduced-scale methods for the determination of 12 common inorganic elements and will give detailed procedures for silica, calcium, tin, and nickel.*

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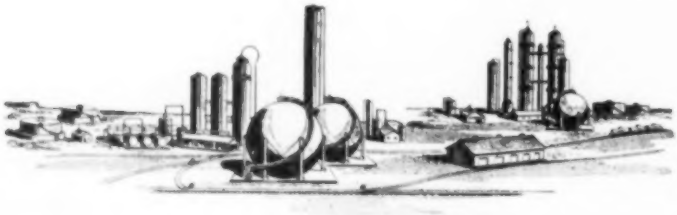

Equipment Stresses Imposed by Piping

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Chicago

PUMPS and turbines in steam and process industries are subject to internal pressures, dynamic forces, weights of piping and valves, and forces from expansion of piping. Most manufacturers generally design them for internal pressures, dynamic forces, and add a reasonable factor of safety, based on past experience, to resist forces from expansion of piping.

Pumps and turbines are purchased on performance basis, and not on their capacity to resist expansion forces from piping. Most manufacturers are generally reluctant to state the maximum forces which their equipment can resist and still operate satisfactorily above normal temperatures. The oft repeated and frequently requested zero loading condition during operation is seldom met in practice. Hence pumps and turbines, in many instances are resisting forces which have not been provided for directly in their designs. As long as the equipment does not break down completely manufacturers are seldom troubled. Maintenance in excess of that required for normal operations are generally taken for granted.

PUMPS and turbines are normally required to resist considerable forces imposed by the expansions of connecting piping. Unless such equipment is carefully investigated, severe over-stresses and pump rotations can result and can have marked effect upon both equipment maintenance costs and service life. This article points out many of the factors involved and outlines procedures to be used in checking equipment items.

It is suggested that the Look Box discussion, "Pump Stresses," page 63, be read in this connection.

Causes of Troubles

One of the major causes of pump and turbines troubles is generally due to excessive forces from expansion of piping. These forces may be caused by:

1) Suction and discharge piping of pumps, and steam exhaust of turbines being too rigid.

2) Improper location of rigid anchors, nullifying flexibility of pipe bends.

3) Improper use of expansion joints.

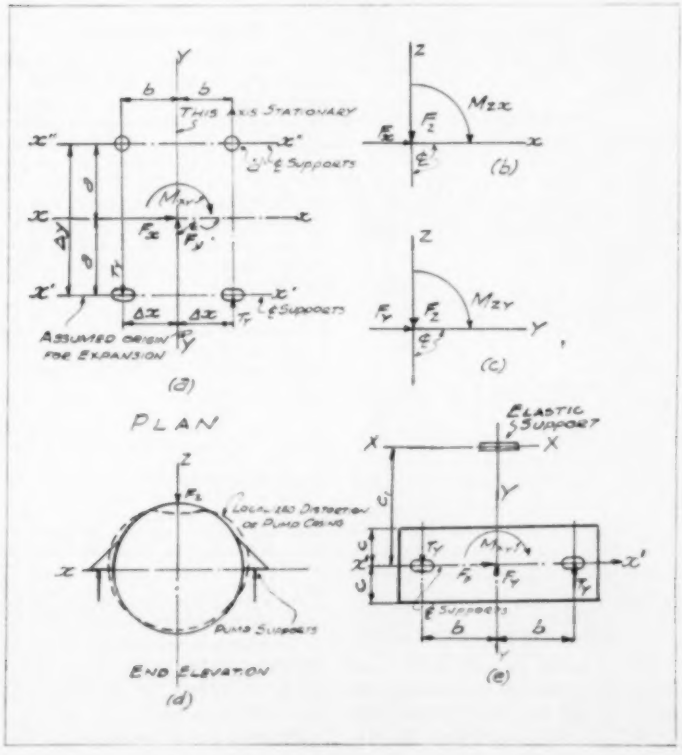
4) Improper use of guides on main piping runs to and from pumps and turbines.

5) Incorrect methods of supporting valves and piping.

6) Too rigid by-passes to spare pumps.

Similarly pumps and turbines may have the following potential points of weakness: flanges too thin, nozzles too weak, casings of insufficient thickness, stud bolts too small, pedestals too flexible, and pump bases of insufficient stiffness.

Figure 1.



Expansion Forces

Every pump and turbines operating above normal temperatures is subject to three direct forces, and three moments caused by expansion of piping. This is the most general case. If the piping lies in plane, number of forces is reduced.

Referring to Figure 1, the three direct forces are shown acting along the three axes X, Y and Z, and are called F_x, F_y and F_z. Also three moments M_{xy}, M_{yz} and M_{zx} are rotating in the XY, YZ, and ZX planes. These forces will be considered as resultants throughout this article.

If pump or turbine has four supports, two of them are generally capa-

ble of resisting rotations in the XY plane. These supports are generally the ones which control origin of expansions. The other two supports are not in a position to resist rotations, since oversized holes are generally provided in the equipment. This is indicated in Figure 1a.

For pumps and turbines operating above normal temperatures, YY axis must be stationary in order to maintain alignment with the coupling. Some type of positive mechanical guying arrangement is provided along this axis on all turbines and most pumps. Expansions in transverse direction of the pump or turbine, relative to YY axis, are absorbed by slotted holes or suitable guides along X′X′ axis. The other two holes along X″X″ must be oversized to absorb resultant expansion of the equipment relative to X′X′ and YY axes.

All four points of support will be effective in resisting rotations in the YZ and ZX planes. The reacting forces will be either tensile or compressive, and will be perpendicular to the XY plane.

These moments tend to lift the pump or turbine about some point such as "d" of Figure 1a. Resisting these moments are moments of weight of piping, valves, equipment itself, and direct forces from expansion. If differential moments cause uplift, suitable studs or clamping devices must be provided to resist this force.

Equations for net uplift can be determined from statics. If F_z is the total direct load coming upon the four points of support, M_{zy} and M_{zx} net resultant moments, and T_z net uplift force to be resisted, the equation is as follows:

$$T_z = F_z\left(\frac{M_{zx}}{2F_z b} + \frac{M_{zy}}{2F_z a} - \frac{1}{4}\right) \qquad (1)$$

where "b" and "a" are distances between supports and center lines of pump or turbine.

The value in parentheses must always be positive, and indicates that tension is present on the farthest stud. If the result is negative, tension does not exist, and all four supports are under compression.

Simultaneously torsional moment in the XY plane may be acting. Resisting this moment is a couple T_y acting through the studs or shear keys along X′X′ axis. The shear T_y on each stud or shear key, assuming frictional resistance as being zero is:

$$T_y = \frac{M_{xy}}{2b} \qquad (2)$$

The resultant stress on the most critical stud bolt is then made up of tensile and shear stresses. These two stresses should be combined according to the maximum shear theory. If shear keys are used, stud bolts would only be subject to tension.

The effect of horizontal shear T_y may at times be greater than net uplift. If T_y when combined with F_y is large, it may deflect pedestals sufficiently enough to cause angular rotation of the pump or turbine as a whole.

Resistance to rotation in the XY plane for pumps and turbines with two supports would be the same as for four. Equation 2 would apply. Net uplift due to moments in YZ and ZX can be determined from equation 3 listed below. One new term has been added, namely distance "C_c" which is the distance from center line of stud bolt to the edge of the base plate.

$$T_z = F_z\left(\frac{M_{zx}}{2F_z b} + \frac{M_{zy}}{2F_z c} - \frac{1}{2}\right) \qquad (3)$$

The value within the parentheses must be positive to indicate uplift. If the value is negative, compression exists.

Some pump and turbine manufacturers provide an auxiliary support at a distance "c_1" as shown in Figure 1e. Origin of expansions is still at X′X′. Expansion over length "c_1" is either absorbed by flexure of the support, or by sliding.

If the flexible support is welded to the underside of turbine or pump, resistance to rotations are increased considerably in the YZ and XY planes. Approximate equations for uplift are given by equation 4, and for torsion by equation 5.

$$T_z = \frac{F_z}{\left(\frac{b}{c_1}\right)^2 + 1}\left(\frac{M_{zy}}{F_z c_1} + \frac{M_{zx}}{F_z c_1} - \frac{1}{2}\right) \qquad (4)$$

$$T_y = \frac{M_{xy}}{2b + c_1} \qquad (5)$$

This type of construction is somewhat undesirable, especially when support for pump or turbine at X′X′, and top of elastic support at XX are at different levels. Differential expansion in Z direction develops indeterminate forces and secondary displacements in YZ plane.

Effect of Forces on Casings

Forces acting through suction and discharge nozzles are transmitted to the casing, which in turn transmits them to the supports. If moments M_{zx} and M_{zy} are large overstressed condition may exist at the junction of nozzle with the casing. These moments may causes appreciable yielding of the casing, decreasing operating tolerances. Substantial ribbing must be provided to distribute moments over larger areas of casing.

Torsional moment M_{xy} has little effect on distorting the casing. Although torsional stresses may be high at the junction of nozzle and casing they generally are not serious. The two direct forces F_x and F_y generally have secondary effects on pump casing. F_y causes direct compression, while F_x shear and bending stresses.

F_z is the more critical force, as it may cause local flexural deformations of the casing as shown in Figure 1d. Deformations from direct load when combined with those due to moments M_{zx} and M_{zy} may decrease clearances between impeller blades and inside of casing.

Frequently pumps and turbines have side inlet or outlet connections. Base ells are sometimes provided and rigidly anchored. This type of construction prevents expansions, and large forces will develop which may effect operation of equipment. The only solution is to disconnect the base ell, and allow the point to move freely.

Permissible Forces

In view of a large number of uncertain factors involved, it is difficult to predict what loadings may be imposed on pumps and turbines operating above normal temperatures. The first indication of possible loadings on pumps was made in a paper by Rossheim and Markl, *Stresses in Pipe Lines Due to Pressure and Expansion*, presented at the annual meeting of American Society of Mechanical Engineers, in December, 1939.

These writers state that a "review of a large number of stress calculations involving pipe line connecting to pumps gave the following averages for end reactions:

F_z, Vertical thrust from expansion, plus weight of pump riser, valves, fittings in lbs. is equal to $3.25D^2$.

F_x and F_y, or lateral thrusts in any direction in pounds $= 1.50D^2$.

Bending or torsional moments, in inch pounds is equal to $60D^3$, where D is equal to outside pipe diameter increased by 3 inches.

Authors of the above article do not state whether above loadings are for reciprocating or centrifugal pumps, or whether pumps have two or more points of support, nor operating temperatures of pumps.

Applying the above rule to centrifu-

gal pump with 6-inch suction, 4-inch discharge nozzles, 8-inch suction and 6-inch discharge piping, the forces would be:

Sum of F_x forces = 8600 pounds.
Sum of F_z, or F_y = 3900 pounds.
Sum of moments in any direction = 160,000 inch pounds.

The above forces appear excessive, even for the much larger type hot oil reciprocating pumps.

A somewhat similar set of rules, developed by the writer, based upon a large number of stress calculations and actual installations, are as follows:

For pumps and turbines with four points of support, and with temperature not greater than 650° F., maximum forces at operating conditions are as follows:

F_z, or vertical force, including weights of valves, fittings, piping, insulation, and direct forces from expansion is equal to 250 times the sum of nominal diameters of suction and discharge piping, with a maximum of 4000 pounds. Any load in excess of the above would be counterweighed or spring supported.

F_x, F_y, lateral thrusts in any direction, 100 times the sum of nominal pipe diameters, with a maximum of 1500 pounds. Any load in excess of the above would require redesign of piping. Moments in any three planes, under operating conditions, 2700 times the sum of nominal pipe diameters in inch pounds, with a maximum of 40,000 inch pounds. Moments in excess of the above acting on the equipment, would require redesign of piping.

For pumps or turbines with two supports, forces are as follows:

F_z is equal to 300 times the sum of nominal pipe diameters, but not to exceed 2700 pounds.

F_x and F_y, lateral thrusts in any direction, are equal to 85 times the sum of nominal pipe diameters, with a maximum of 900 pounds.

Moments in XY plane are equal to 1700 times the sum of nominal pipe diameters with a maximum of 18,000 inch pounds.

Moments in ZX plane are equal to 1700 times the sum of nominal pipe diameters, with a maximum of 22,000 inch pounds.

Moments in ZY plane, 10,000 inch pounds maximum.

For cast iron turbines, above values should be decreased by some reasonable factor. A factor of 0.6 has been applied with considerable success for a long period of time, without any noticeable effects on performance.

As operating temperatures begin to increase above 650° F., the various recommended forces should be decreased by 15 percent for every 50° temperature increase. At an operating temperature of 800° F., the maximum permissible forces on pumps or turbines, should be 55 percent of those indicated.

During erection, when pre-strain of the piping is taken into account, the forces indicated can safely be doubled. This condition being a temporary one, and is relieved during operating period.

Conclusions

The indicated range of forces, in the writer's opinion, are maximum values which may be imposed on pumps and turbines, and still have trouble free performance. These values are solely for standard types of equipment, and are not indicative of the forces and moments which may be imposed on large sized turbines operating electric generators.

A far more desirable condition would be to prestrain suction and discharge piping completely, using pumps and turbines as anchors. This would place maximum stress on equipment cold, and theoretically zero stress under operating conditions.

Complete pre-strain would leave pumps and turbines with a considerable margin of safety, to cope with any emergencies arising out of plant misoperation. Such a practice would increase over all safety, lengthen useful life of pumps and turbines, and reduce maintenance costs.

Complete pre-strain can be accomplished without additional costs by utilizing flexible properties of bends and weld ells to their fullest extent. Field erection costs are insignificant, when compared with the cost of the project.

NOTE

The author, Mr. Wolosewick is connected with Sargent and Lundy, Engineers, Chicago.

* * *

NEW USE FOR FURFURAL PROCESS

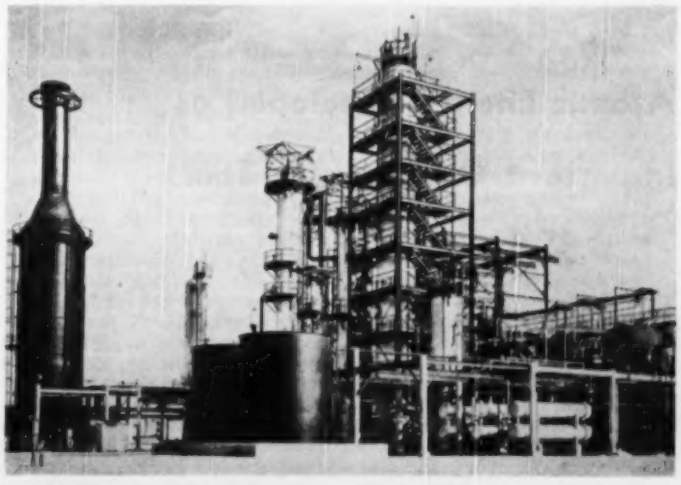
The first commercial use extraction unit employing furfural as the solvent and specifically designed for the production of Diesel and domestic heating fuels was announced last month by Michael Halpern, vice president in charge of refining, The Texas Company. Widely used by the oil industry for the removal of sludge producing elements in motor oils, the furfural process has been adapted to the new use in a commercial unit operated by The Texas Company at its new $60 million refinery at Eagle Point, N. J. (Photo at right.)

Substantial improvement of cetane number in diesel fuels, improving burning quality of domestic heating fuels, and the reduction in sulphur content of all products have resulted, Halpern said.

In effect, the process upgrades catalytic cycle stocks to virgin gas oil quality.

Design of this unit resulted from study of laboratory data and pilot unit work as well as two years' operation of a semi-commercial plant at The Texas Company's Los Angeles refinery. This semi-commercial plant produced as many as 2500 barrels per day of refined gas oils from various charging stocks—"all satisfactorily extracted with furfural," Halpern reported.

Early output of this commercial unit "has closely duplicated product qualities" obtained previously in pilot unit studies refining the same stocks. This unit embodies two fractionators, a simplified treating tower, and product strippers



and is designed to operate on a variety of gas oils differing widely in boiling range, with either high or low sulphur content and either moderately or deeply cracked stocks.

Because unit operates at extraction temperatures only slightly above atmospheric, operating expense for heat input is unusually low, it was pointed out.

The Atlantic Refining Company uses atomic energy successfully in motor oil research in its Philadelphia laboratories. Clifford J. Wirth, using tongs to lessen exposure to the dangerous rays, installs an engine part made radioactive in the atomic pile at Oak Ridge while Hugh R. Jackson checks the amount of radiation with a Geiger counter.

Atomic Energy Developed as Important Oil Research Tool

RESEARCH in the Philadelphia laboratories of The Atlantic Refining Company is showing that atomic energy may be successfully used in the petroleum industry.

Company scientists, working with engine parts made radioactive in the atomic pile at Oak Ridge, Tenn., have made great improvements over the previous method of measuring the effect of different motor oils on the wear in automotive engines.

In a short period of engine operation, they can now determine the exact amount of radioactive iron particles which have been worn from the engine and calculate immediately the extent of damage. This is done by measuring the radioactivity of the used oil which contains these particles. The speed and accuracy of this test opens the door to great progress in the constant research to improve the quality of motor oils, officials believe.

Atlantic in 1943 was granted a patent in the use of atomic energy in petroleum research. The company's first experiments in this field were made with a cyclotron, several years before the atomic pile at Oak Ridge became available for that purpose.

The use of atomic radiation as a research tool is proving so effective that Atlantic scientists are extending its application to experimentation with other petroleum products and processes. By using a Geiger counter, scientists are able to trace, through various complicated chemical and biological processes, atoms which give off radiation and are known as radioisotopes.

By the previous method of checking engine wear, it was necessary to run an engine up to 500 hours, the equivalent of about 20,000 driving miles. Then the engine was torn down and the critical parts weighed to determine how much of the iron had worn off. Then to test another grade of oil, the engine had to be reassembled and another similar test run. This tearing down and rebuilding prohibited an absolute uniformity of engine conditions for the two comparative tests.

When the irradiated parts are used, the test is made on the oil and not on the metal. The advantages of this method are striking.

The engine need be run for only about three hours, or approximately 200 driving miles. Two oils can be tested in the same engine with an exact duplication of operating conditions. Thirty tests can be made in the time needed for one test by the previous method.

When the test run is completed, a metal cylinder containing a Geiger counter is dipped in the oil sample. This instrument immediately records the amount of radioactive iron particles suspended in the oil and fixes with complete accuracy the extent of wear.

Under the terms of its contract with the Atomic Energy Commission, Atlantic receives irradiated engine parts from Oak Ridge each month.

The engine wear research is directed by Hugh R. Jackson. Two Atlantic scientists, who have completed a course in the safe techniques of using radioisotope tracers in research, are Dr. Samuel W. Levine and Dr. John H. Ramser, who are studying other applications of atomic energy in petroleum research.

BUBBLE TRAYS---
Design and Layout

PART 1

JAMES A. DAVIES
The Texas Company, New York

Figure 1. Removable Caps and Risers. (Tray diameter, 3 feet, 6 inches; cap diameter, 6 inches; riser diameter, 4 inches.) Courtesy F. W. Glitsch & Sons.

THERE have been numerous papers written on bubble tray design,[1, 2, 11, 12, 15, 19, 21] and some have included theoretical discussions of various phases. None of these, it is felt, is sufficiently complete so that a satisfactory tray could be designed without recourse to an appreciable amount of practical experience, and to other miscellaneous articles covering specific phases of bubble tray design.

An attempt to give sufficient information as to practice, theory and procedure will be made here to allow a person without considerable experience to design a satisfactory bubble tray. It is readily admitted that while considerable progress has been made in putting various phases of bubble tray design on a fundamental basis, it is still largely empirical. Hence, there will be design ideas given here with which some designers will not agree, and these ideas may very well be incorrect, but the trays designed according to the procedure to be given here have proven satisfactory.[2] Also, there are indications that bubble trays give about the same efficiencies even though they are of considerably different types.[2, 5, 14, 20]

A "satisfactory" tray must meet all of the following conditions:

1) *Low cost consistent with satisfactory corrosion resistance.*
2) *Easily handled, installed and cleaned.*
3) *High vapor and liquid capacity.*
4) *Low vapor pressure drop.*
5) *High efficiency under high and low loads and under mildly unsteady loads.*

These conditions are given in the order of importance. Efficiency is given fifth here since most commercial bubble trays apparently give about the same efficiency under the same conditions. Some of the conditions such as low vapor pressure drop are opposed to other conditions such as high liquid capacity and high efficiency. Hence, the maximum value attainable for any condition is not necessarily the best value to incorporate into the design, since one condition must be balanced against the other conditions for each case.

In Table 1 there is shown a list of common metals used in tray constructions and their cost ratio. It is interesting to note that cast iron, a most common tray construction material, is about as expensive as 11-13 percent chromium steel. It indicates that it is

THE BUBBLE TRAY is possibly the most important single item of equipment used in petroleum processing plants. Along with the fired heater, the pressure vessel, the catalytic reactor, the pump, the valve, and the pipe, it forms the base upon which a great and prosperous industry has been built.

Despite the use of tens of thousands of these trays, both their initial design and their performance in operation still present certain mysteries to engineers and operators alike. Operating variables are many and tray performance of necessity is evaluated by empirical methods. Most fractionation specialists have their individual procedures for estimating performance and making tray selections. Many articles giving details of specific factors of tray design or performance have been published. These details are widely scattered through the literature and have originated from many sources. Comparatively little has appeared on the over-all problem of setting up tray layouts and tower sizes for a given set of design conditions, or checking tray loadings in actual plant operations.

In this series of two articles, the author, long experienced in the design of bubble trays for all types of petroleum distillation apparatus, has organized the whole tray calculation problem into an orderly routine. He has attempted to give sufficient information as to practice, theory, and procedure to allow a person without considerable experience to reach sound answers on bubble tray problems. This, Part I, deals with the mechanical details of the bubble tray art. Part II, to appear in an early issue, will cover the actual calculation of tray performance.

cheaper to use a thin corrosion resistant metal than a metal which has to be thick because of corrosion expected. In general, the gauge metal trays are preferable to cast or welded trays, not only from a cost standpoint, but, as will be pointed out, from a maintainance standpoint as well. A cast iron or welded tray also will not have as high a capacity as a gauge metal tray because of the space taken up by the metal in the caps and risers.

Detailed discussion of metals which should be used in tray construction to combat corrosion will not be included here. It will be sufficient to say, that in the petroleum industry where mild corrosion normally occurs, steels having a medium content of chromium are widely used. These steels are the 11-13 percent chrome type. Bolting and nuts should always be made of material with good corrosion resistant properties so that they can be unfastened easily after being in service.

TABLE 1
Construction Metals and Comparable Costs**

Sheet Metal Trays	
Carbon Steel	1*
4-6 Percent Chrome ½ Moly Alloy Steel	2-3
11-13 Percent Chrome Type 410 Alloy Steel	2½-3¼
Red Brass	3-3½
18-8 Type 304 Stainless Steel	3-3½
18-8 Type 347 Stainless Steel	3¼-4
Monel	3½-4½
18-8 Moly Type 316 Stainless Steel	4½-5½
Inconel	4½-5½
Hastelloy	25-35
Other Trays	
Cast Iron	2-3½
Welded Carbon Steel	1½-3

* Fabricated Carbon Steel Trays cost approximately 20-25 cents per pound.

** Costs shown are fabricated costs per unit area of tray.

Table 2 shows weight per square foot of tower-area. The weight per square foot value is an important factor to know since from it can be estimated the price and weight of the tray. The tray weight must be known in order to design the shell attachments for supporting the trays and to check the tower foundations. It will be noted that the larger the tray the heavier it becomes per square foot. This is due to the increase in size of the tray beams to meet some specified maximum allowable deflection for the larger span obtaining in the larger diameter towers.

As the gauge metal trays are considerably lighter than cast or welded trays, they will be easier to handle and install in the tower. They can be more easily cleaned as they can be removed from the tower for cleaning without even having to remove the caps. It is normal practice to remove the caps when unpacking a tower filled with cast iron trays to facilitate the work. It has been found by experience that light-weight steel trays can more quickly be taken out of a tower, cleaned, and put back into the tower than can cast iron trays.

Mechanical Details

Figure 1 shows a type of riser and cap assembly that facilitates cleaning. Cap hold-down arrangements should not interfere with the liquid flow. Bars laid on top of caps for cap hold-down are objectionable because they tend to dam up the liquid flow.

In addition to providing easily re-

Nomenclature

A_a total annular area per tray between the inside of the caps and the outside of the risers, square feet.
A_c total inside cross sectional area of caps per tray, square feet.
A_d constriction area, taken as the smallest area found in the downflow, usually taken as the flow area between the bottom of the downflow and the tray floor, square feet.
A_m smaller of the areas, A_a or A_r
A_r total reversal area per tray between the inside top of caps and the top of the risers area usually taken as the cylinder between the cap and the riser of diameter equal to the average of the inside and outside diameters of the top of the risers, square feet
A_s total cap slot area per tray, taken as the area between the teeth in the caps, square feet
A_n total riser area per tray, square feet
C_s liquid gradient factor
D clear liquid height in downflow above height of liquid at overflow weir (assuming no inlet weir), inches of clear liquid
F free height in downflow, inches
M correlating factor for obtaining the wet tray pressure drop from Figure 7
O_h maximum horizontal distance liquid travels in flowing over a weir and dropping down the downflow, measured from the weir, inches
Q clear liquid flow, gallons per minute
V total vapor rate per tray, cubic feet per second
V_s superficial slot vapor velocity, based on the total slot area, feet per second
$V_{s(min)}$ minimum superficial slot vapor velocity, feet per second

h distance between adjacent caps and/or uptakes in a row normal to flow of liquids, inches
d_c inside diameter of caps, inches
d_l total flowing clear liquid depth adjacent to overflow weir, inches
d_s cap slot height, inches
d_r inside diameter of risers, inches
h_v total vapor pressure drop per tray, inches of clear liquid
h_d total pressure drop through risers and caps on a wet tray, inches of water
$h_{d'}$ total pressure drop thru risers and caps on a dry tray, inches of water
h_r pressure drop thru the cap and riser reversal area, inches of water
h_s pressure drop thru dry slots running wide open, inches of water
h_t depth of notches in weirs, inches
h_l head of liquid flowing over weirs, inches of clear liquid
h_i static submergence, difference in height of overflow weir and the top of slots, inches
h_p pressure drop thru caps and risers for wet tray (assumes vapor is evenly distributed among the caps and risers), inches of clear liquid
$h_{p(max)}$ maximum pressure drop thru caps and risers resulting from operating with slots just wide open, inches of clear liquid
h_a liquid pressure drop thru downflow and constriction area, inches of clear liquid
l_w weir length, taken straight across top of weir, inches
l_1 total free space between caps normal to liquid flow, average of various rows, inches
l_2 total free space between risers normal to liquid flow, average of various rows, inches
m distance between top of risers and top of slots, inches
p_h total pressure above liquid level, inches of clear liquid
p_b total pressure below tray, inches of clear liquid
r number of rows of caps perpendicular to liquid flow
s Cap skirt clearance, distance of bottom edge of cap above tray floor, inches
t Tray spacing, inches
u superficial tower vapor velocity (based on total tower area), feet per second
w Minimum distance between caps and/or risers in adjacent rows of caps and risers, inches
$(h/w)_a$ Average of ratios of distances between caps and between risers

α l_2/l_1
β $(h/w)_a$
λ liquid gradient, difference in clear liquid levels between inlet and outlet sides of tray or tray section, inches
$\lambda_{1.1}$ liquid gradient at condition of $uV\rho_v = 1.1$
λ_x liquid gradient at condition of $uV\rho_v = x$
ρ_v vapor density, pounds per cubic feet
ρ_l liquid density, pounds per cubic feet

movable caps and, if necessary for cleaning, risers, it is advisable to make the tray sections easily detachable from the tower with a minimum of bolts or clamps. A most important factor in this respect is that the bolts or clamps should be accessible from the top side of the tray. This will make it unnecessary to have a man underneath to loosen the tray sections with the loss of time in opening up a manway to gain access to the lower tray. Careful attention should be paid so that the bolts or clamps, support beams, etc., do not interfere with liquid or vapor flow.

Other mechanical and constructional details that are considered in tray design will be listed and discussed as follows (see Figure 2 and Nomenclature for definitions of terms used):

1) *Foundations:*

As a rule the tower foundation is not much affected by the weight of trays. The size of the foundation is usually the same whether the tower is packed with cast iron trays or with 12-gauge carbon steel trays. This follows from the fact that the size of the foundation required is normally set by the size required to resist overturning action. However, if the direct loads of the foundation require a larger foundation than that based on resisting overturning action, the weight of the trays would directly affect the size of the foundation and gauge metal trays would have some advantage over cast iron or welded steel trays. However, since towers are frequently given a hydrostatic pressure test, the weight of the trays whether cast iron or gauge metal is small compared with the total direct load.

2) *Thermal Expansion:*

It must be assumed at all times in the design of a tray that the metal temperatures of the various tray sections and the shell will not be the same. The tray design should incorporate provision for absorbing thermal expansion. This is usually done by using slotted bolt holes and allowing clearances between the tower shell and the tray. However, these provisions should also be made to facilitate installation as discussed below. Thermal

TABLE 2

Tray Material Weight Per Tray Area

Pounds Per Square Foot of Tray Area

Metals Thickness	Cast Iron ½"	Carbon Steel 10 Ga.	Type 410 12 Ga.	Type 410 14 Ga.
Tray Diameter				
6'-0"	60	24	20	17
8'-0"	65	26	22	19
12'-0"	75	30	26	23

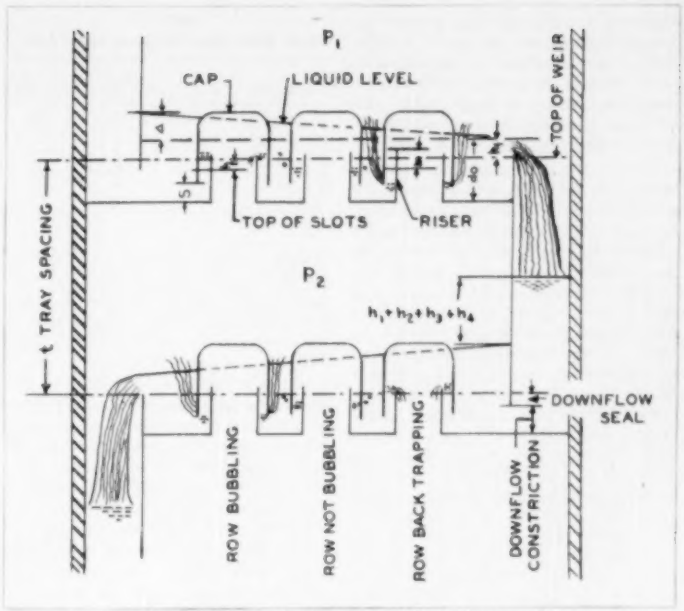


Figure 2. Cross Section of Bubble Tower with Single Cross Flow Trays

expansion considerations will rule out any chordal members, whether downflow baffles, beams or tray sections, welded at both ends to the shell. If insufficient provision is made for thermal expansion the trays are likely to buckle and the beams may become warped. Provision of ½ inch per 10 feet of diameter is satisfactory for thermal expansion. However, more clearance is provided usually for ease in installing trays.

3) *Tray Hold-Down:*

Both cast iron trays and lighter weight trays need to be securely tied down to the tray support members. A bubble tower is subject to pressure surges, at times of sufficient violence to lift the tray from the supports if it were not tied down. Violent pressure surges have been known to break every cast iron bubble tray in a tower even though they were fastened. An advantage of the gauge metal trays is that considerable parts of them can be salvaged for reuse by straightening after sustaining a violent pressure surge. The causes of these surges are manifold, and sometimes are caused by explosions resulting from air in the system, or by sudden introduction of water into a tower operating under a temperature considerably above the boiling point of water.

4) *Tower Roundness:*

Not only sufficient clearance must be provided between the shell and the tray sections to allow for thermal expansion, but additional clearance must be available so the tray will fit easily into the tower. Both the tray and the tower will not be perfectly circular. It is practice to specify that the inside diameter of the tower be held to ± 1 percent of the nominal diameter, while the tray is held to ± 1 percent of some nominal diameter less than the tower diameter depending on the size of the tray support ring. Frequently a 1-inch bearing surface under the tray is provided on the ring supports with a 1-inch clearance between the trays and shell.

5) *Tray Level:*

All tray calculations are made assuming the tray deck is perfectly level; however, as this is not possible in practice, some thought must be given to the causes, effect and magnitude of tray out-of-levelness. The important and common causes are as follows:

a) Tolerance allowed in locating the tray supports in the tower and making the attachments fast to the shell. It is possible to locate the attachments and supports correctly with a tolerance of ± ⅛ inch vertically or circumferentially.

b) The tower initially is set in its foundation so that the top may be 1 inch out from the tower vertical. For a tower 120 feet high and 12 feet in diameter, this amounts to the tray being out of level a maximum of ⅛ in.

c) Uneven tower foundation set-

tlement will cause the tray to tilt. No generalizations can be made on the amount of settlement to be expected, as it depends on so many factors. A foundation under a large tower was noted in one case to have settled in three years by ⅛ inch in 10 feet.

d) The tray will also deflect under load. This deflection will normally be a maximum at the center of the tray, as opposed to the above two ways wherein the maximum effect occurs at the periphery. The load is usually assumed to consist of water up to the highest weir setting, or 5 inches. It is easy to design satisfactory beams to give 1/16 inch maximum deflection for tray diameters up to 10 or 12 feet. Above these diameters the beams become so large that it is difficult to design a beam that will not interfere with the trays themselves. Hence, ⅛ inch maximum deflection are frequently specified for larger diameter trays. The deflection of the beam must be checked for the beam in the uncorroded state as well as in the corroded state. It came to the attention of the writer that a certain beam for a large diameter tray that gave 1/16 inch deflection in the corroded state, deflected nearly 1/16 inch under only its own weight in the uncorroded state due to the large corrosion allowance provided. If the size of the beam becomes impractical to meet a certain allowable deflection, the beam can be reduced in size by specifying that the beam be given a cambre so that the given deflection will be met under load. Table 3 shows some typical sizes of beams for different tower diameters.

e) Uneven corrosion of the tray deck itself or of the support beams will cause the tray to be out of level. Corrosion allowances applied are normally of the range of ⅛ to ⅜ inch.

f) Deflection of the tower under a large horizontal wind load. The maximum vertical deflection is frequently taken as 2½ inches for every 100 feet in height. This means that for a 12-foot diameter tower 120 feet high the tray will be ¼ inch out of level during a high wind.

g) In the manufacture of the trays the height of the cap slots and the top of the weirs above the tray floor is kept to within a tolerance of ± 1/16 inch. In setting the cap and weirs in the field this tolerance is seldom obtained.

From the above given magnitudes of differences in tray levels it can be seen that if they were all additive the tray would be seriously out of level. However, such is not the case. Even for large diameter trays it is safe to assume the maximum difference in tray levels will be ½ inch. This value

TABLE 3

Major Beam Sizes for Sheet Metal Trays

Tower Diameter	Beam Depth	Allowable Deflection
4'-0"	4"	1/16"
6'-0"	4"	1/16"
8'-0"	5"	1/16"
10'-0"	6"	1/16"
12'-0"	10"	1/8"
16'-0"	14"	1/8"
20'-0"	18"	1/8"
24'-0"	22"	1/8"

should be kept in mind when setting up seal dimensions for the tray. Sufficient seals should be provided that a positive seal will be present even if the difference in tray level is ½ inch. This applies particularly to the downflow seals. Also, since it is most important to have the static submergence as constant as possible and a good liquid distribution across the tray, the tray out-of-levelness should be compensated for by notched weirs, or weirs that can be cocked to compensate for the tray out-of-levelness. Adjustable caps will compensate for changes in static submergence.

6) *Tray Beams:*

In addition to giving a maximum deflection of a certain specified small amount, the beam must not be overstressed when workmen are standing on the tray or when other tray sections and equipment are stacked on it. This load is sometimes given as some weight value per square foot for the whole tray concentrated in a given area in the center of the tray. For example:

For trays up to 12 feet diameter the live load shall be 15 pounds per square foot of tray area and assumed concentrated in the center of the tray at 100 pounds per square foot.

The allowable deflection normally determines the size of the beam at the center of the span so the beam can be made smaller and lighter at the support ends. This can be made use of in providing access openings at the ends of the beams to allow workmen to get from one side to the other.

Also the beams should be located parallel to the liquid flow across the tray.[3] The liquid flow induces a cross vapor flow, and having the tray beams located parallel to this flow will keep the cross flow vapor velocity to a minimum.

7) *Support Rings:*

The attachment to the shell wall that supports the tray and frequently the tray beams is a ring welded circumferentially around the shell. It should form a closed ring if possible, since it will help stiffen the tower to withstand a higher external pressure. Frequently, however, having a ring angle through the downflow section will cause the tower to prime. If the downflow residence time is around 15 seconds or higher, continuous ring support may be used without causing trouble.

8) *Weep Holes:*

Holes should be provided in the trays for draining liquid off when the tower operation is shut down. The weep holes should not be so small that they will become plugged with dirt nor so large that appreciable liquid will pass through during operation. The sizes generally range from ¼ to ⅝ inch. It is frequent practice to locate them close to the overflow weir as possible so that if liquid does pass through during operation, it will take approximately the same path as if it passed down the downflows. All low points should be drained. Sufficient number of holes are required to drain a large tower with many trays in a few hours. Satisfactory drainage will be obtained if one square inch of weep hole area is provided for each 100 square feet of tray area.

9) *Leakage:*

In order to insure no liquid or vapor by-passing around a tray, trays are built so as to be able to hold water without leakage except through the weep holes. All bearing surfaces are frequently provided with asbestos gaskets and care is taken that no holes are present except the weep holes. It is common practice to fill the trays with water upon installing in towers to test for tightness. Too much emphasis on water tightness is frequently made. While a tray may leak badly when filled with water, it may be perfectly tight under normal operating conditions. The tray vapor pressure drop tends to eliminate liquid leakage. Also, a water test does not reveal places where vapor can by-pass a tray above the liquid level.

Trays operating under a pressure of a few millimeters of mercury must be made much tighter to eliminate liquid by-passing. Trays in this service should be sufficiently tight under a water test that the water level will not drop more than 1 inch in 20 minutes.

10) *Dirt, Coke, Scale, Etc.:*

Since the liquid processed in a bubble tray will contain usually some solid material such as dirt, coke, scale, etc., some consideration must be made to avoid trouble with deposition of it on the trays. Some tray designers set the bottom of the caps close to the tray floor so that the vapors will sweep the surface of the tray free of sediments. Other designers feel that sedimentation will occur nevertheless, so, they set

the caps sufficiently high over the tray floor so the sediment will not build up enough to clog the slots before the trays can be cleaned at the regular turnaround period. For instance, for clean stocks the bottom of the cap slots are set $\frac{1}{2}$ inch above the tray deck; for unusually "dirty" stocks a height of $1\frac{1}{2}$ inches is used. The normal height is 1 inch.

Pockets and low places on the trays are avoided as far as possible since it is felt that these would fill up with sediment. Inlet weirs and pots frequently are not used for this same reason.

Petroleum tends to coke at high temperature. In order to minimize this tendency, the liquid holdup capacity of any part of the tray is kept to a minimum. For instance, the depth of any side stream drawoff pots or troughs is made as small as possible. It has been found from experience that coke does not tend to adhere nearly as readily to stainless steel surfaces as it does to carbon steel or cast iron surfaces.

11) *Accessibility:*

Trays must not only be designed to give good fractionation, but must be designed to give easy access for inspection and maintenance. If the tray is removable from the tower, it must be designed to easily pass through the manways. A manway that is frequently used has a 24-inch outside diameter. The tray sections should be designed to pass the manway with the caps in place to obviate the necessity of having to remove all the caps before removing the section. Easily removable caps should be provided. When it is necessary to remove caps for cleaning, it should be possible to fasten or unfasten the tray-sections from the supports from the top side of the tray. This eliminates having two men, one above the tray and one below, for securing the tray to the supports. Frequently, permanent trolley beams are provided in towers to facilitate tray removals. Where it is possible, the trays are cleaned in place without removing from the tower. This means that internal or tray manways are provided to allow access to any tray and any part of a tray. Beams are notched at the ends to facilitate access from one tray section to another. In cases where the caps are closely spaced and it is desired to clean the tray in place, removable caps and risers are provided. These should also be removable from the top side.

In order to provide sufficient room to allow men to work between trays in place sufficient tray spacing must be provided. Since the depth of beams increase with increase in tray diameter, the tray spacing must be increased to allow satisfactory access space. Table 4 is given as a guide to satisfactory tray spacing.

TABLE 4
Recommended Tray Spacing

Tower Diameter	Tray Spacing
4'-0"	20" (No Manways in Trays)
6'-0"	24"
8'-0"	24"
10'-0"	24"
12'-0"	30"
16'-0"	30"
20'-0"	30"
24'-0"	36"

12) *Inlet Arrangements:*

Care must be taken in designing the reflux and charge inlet arrangements to avoid harming the fractionation efficiency. The aim is to obtain as good distribution as possible of the liquid and vapor coming into the fractionation tower. It is good practice to provide inlet weirs for outside reflux. These weirs serve to distribute the reflux over the tray and dampen out fluctuation of reflux inflow rate caused by reciprocating pumps or control instruments. Notching the weirs improves the dampening characteristics and give better distribution if the tray is not level, especially when the liquid load is small.

If the charge is below its bubble point, it is normally introduced into the downflow section. If it is above its dew point, it is introduced into the vapor space underneath a tray, taking care that the inrushing vapor cannot disturb the liquid on the tray. This can be accomplished by obtaining low inlet velocities through the use of large inlet pipes and by directing the vapor towards the shell of the fractionating tower.

The design of the inlet arrangement in the case where the charge is a mixture of vapor and liquid is more difficult. Liquid separators of one kind or another are frequently provided. Where the quantity of charge is small compared to the vapor and liquid loads on the tray, the inlet can be provided with a vertical chamber open at both ends and located over the downflow section.[2] Considerable separation of vapor and liquid will occur in the chamber and the liquid will drop out into the downflow section and the vapor escape into the vapor space. Where the charge is large as in crude towers, elaborate entrainment separators consisting of entrainment baffles or spiral horns are provided. In these towers, if the vapors passing through the trays above the inlet zone contain entrained liquid particles, the color and carbon residue of the lowest side stream product will be adversely affected. Even a simple inverted chimney entrainment separator will improve the color and carbon residue of this drawoff stream.

A few points of caution should be observed in laying out the inlet arrangements. These are as follows:

a) If the charge liquid is hotter than the liquid contained in the downflow section into which it is being directed, some vaporization will occur. These vapors will limit the downflow capacity and are apt to cause the tower to prime. If such be the case, the liquid should be directed to the center of the bubble cap section, eliminating a few caps and risers to give space for the liquid to spread itself out on the tray without harming the hydraulic conditions on the tray.

b) Hot vapors, if they are directed towards a downflow baffle, may easily cause vaporization in the downflow section. Vapors hotter than the internal reflux should be directed away from the downflow baffle.

13) *Drawoff Arrangements:*

Sidestream drawoff arrangements do not normally cause trouble. However a few rules must be observed in designing the drawoff. It takes a certain head of liquid at the entrance to the drawoff pipe to force the liquid into the pipe, through the horizontal run of pipe through the tower shell, through the shutoff valve, and into the elbow or tee in the vertical run of pipe to the ground. This required head of liquid must, of course, be less than the head of liquid actually expected at the entrance to the drawoff pipe. Drawoffs are most commonly located in the tray inlet pan in the downflow section from the tray above.

In crude unit towers the lowest side stream drawoff is apt to be operated with the drawoff valve wide open, thereby drawing off all downflowing liquid from the tray. A positive liquid seal must be provided for this drawoff to prevent vapor from passing up the downflow when all liquid is being drawn off. Also, the seal must prevent liquid from lying on the tray downstream from the point of withdrawal when all liquid is being withdrawn. Normally, if the drawoff is located in the tray inlet pan and all liquid is being withdrawn, the head required to force the liquid into the drawoff pipe is less than the head of liquid required to force the liquid onto the next tray under the downflow baffle. Consequently, there is no seal present and vapors are free to pass up the downflow in which the drawoff is located. These vapors will limit the downflow capacity and completely by-pass the tray above the downflow baffle. To

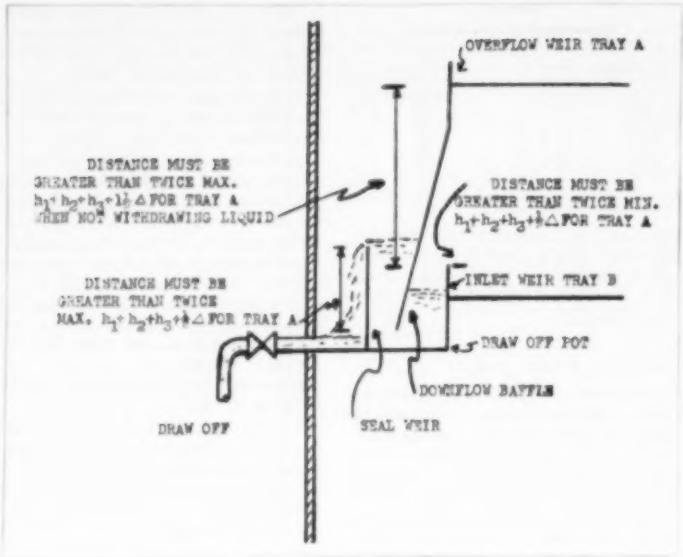

OVERFLOW WEIR TRAY A
DISTANCE MUST BE GREATER THAN TWICE MAX. $h_1+h_2+h_3+\frac{1}{2}\Delta$ FOR TRAY A WHEN NOT WITHDRAWING LIQUID
DISTANCE MUST BE GREATER THAN TWICE MIN. $h_1+h_2+h_3+\frac{1}{2}\Delta$ FOR TRAY A
INLET WEIR TRAY B
DISTANCE MUST BE GREATER THAN TWICE MAX. $h_1+h_2+h_3+\frac{1}{2}\Delta$ FOR TRAY A
DRAW OFF POT
DOWNFLOW BAFFLE
DRAW OFF
SEAL WEIR

Figure 3 Draw-Off With Seal

maintain a seal at all times, a dam may be located in front of the drawoff entrance of a height somewhat greater than the height of liquid required in the downflow to maintain a seal for the bottom of the downflow baffle.

In addition to the above, it is advisable to provide an inlet weir onto the tray downstream from the downflow baffle since it is objectionable to have stagnant liquid on a tray. This weir should be of sufficient height to prevent liquid from flowing over it when all liquid is being withdrawn, but insufficiently high to cause priming when no liquid is withdrawn. See Figure 3.

It is advisable when calculating drawoff liquid heads to assume that the actual liquid density is half that of clear liquid and that, consequently, the drawoff liquid rate is double. Also one should assume the same low liquid density when determining the various dam heights in Figure 3.

14) *Buffer Trays:*

While this article will not deal with the number of trays required to produce the desired separation, there are cases where extra trays must be provided because of the large temperature gradients. This condition is prevalent in crude towers. For instance, one or two "buffer" trays should be provided below the lowest side stream withdrawal point to protect the quality of the bottoms product even though all the tray liquid is withdrawn and the buffer trays are nominally dry. Due to the high temperature gradient obtaining in this section, the colder liquid on the tray above the withdrawal point induces some condensation on the under side of the tray. If there were no tray to catch this induced reflux and if it were of sufficient magnitude, it would tend to lighten the bottoms product.

Another case where a buffer tray may be required is just above the point of cold intermediate reflux entry. An entering cold stream causes an inverse liquid temperature gradient above the entry point by inducing reflux on the tray above. If a drawoff point is located above this entry point, the withdrawal temperature may be too low to produce the desired side stream unless a buffer tray is provided on which the inverse temperature gradient will occur.

15) *Standardization:*

For the ordinary tray requirements it is only necessary to have two different types of tray design with the same diameter. One type of tray would handle a load with a low vapor-to-liquid ratio while the other would be used for loads with high vapor-to-liquid ratios. Both types of trays would be single cross flow with the following characteristics:

	High Vapor-Liquid Ratio	Low Vapor-Liquid Ratio
Number of Caps	Large	Small
Size of Downflows	Small	Large
Uses	Low Pressure Towers Strippers	High Pressure Towers Absorbers

In some cases two pass or split flow trays are necessary, but it is felt that except for very large diameter towers with exceptionally high liquid loading a single pass tray can be designed to handle satisfactorily most large liquid loads. A single pass tray can be designed to handle liquid at the rate of 150 gpm. per foot of diameter. If two-pass trays are required, each section should have at least five rows of caps in order to take advantage of increased efficiency brought about by a liquid consentration gradient that will be present.

The subject of tray design is discussed fully in the following sections, but it should be pointed out here that a standard tray design should be used wherever possible. The use of standard trays has the following advantages:

a) *Less replacement parts need be carried in storehouse stocks.*

b) *Facilitates procurement of new trays as the design and drawings are already available.*

c) *Surplus trays can be easily adapted for installation with new or existing trays.*

In setting up the basic tray design for standardization the design must be flexible. This can be done by providing adjustable weirs and caps that can be raised or lowered.

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(End of Part I. Part II will appear in an early issue.)

Catalytic Cracking

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PART II

***PART II OF THIS SERIES** on catalytic cracking is concerned with the Thermofor catalytic cracking process in contrast to the fixed-bed type units of Part I. The discussion, containing a large number of references, is concerned with the process, control problems, catalyst transfer, regeneration of catalyst, catalyst, and late developments in the process.*

The successful performance of a 500-barrel-per-day semi-commercial unit for a period of over two years preceded the installation of the first commercial size unit, which went on stream in October, 1943. Among the important features of this process, responsible for its wide acceptance in the refining industry, are the low construction and operating costs.

THE Thermofor catalytic cracking process[37] is a moving-bed process in contrast to the Houdry processes. Instead of having a stationary bed of pellets supported on a screen, through which oil vapors flow, these pellets are transported mechanically in the Thermofor process, fresh catalyst being constantly introduced to the reactor and spent catalyst being constantly withdrawn. This increases the utility factor of a given reaction vessel from about 33 percent in the Houdry process to 100 percent in the Thermofor process, because regeneration takes place in a separate vessel.

The TCC process was developed by Socony-Vacuum Oil Company[44] and installation of commercial TCC plants was preceded by the successful performance of a 500-barrel-per-day semi-commercial unit operated for more than two years. The first commercial TCC unit went on stream on October 7, 1943.[34] Licensing agents for the TCC process include the Houdry Process Corporation, E. B. Badger & Sons Company, and The Lummus Company.[19]

Important features of TCC plants may be itemized as follows:[18]

1) Low construction and operating cost.
2) Extensive use of conventional refinery equipment.
3) Low requirements of strategic materials.
4) Use of low-pressure blowers instead of compressors for supplying regeneration air.
5) Conversion of regeneration heat to high-pressure steam.
6) Adaptability to small- as well as large-scale refineries.

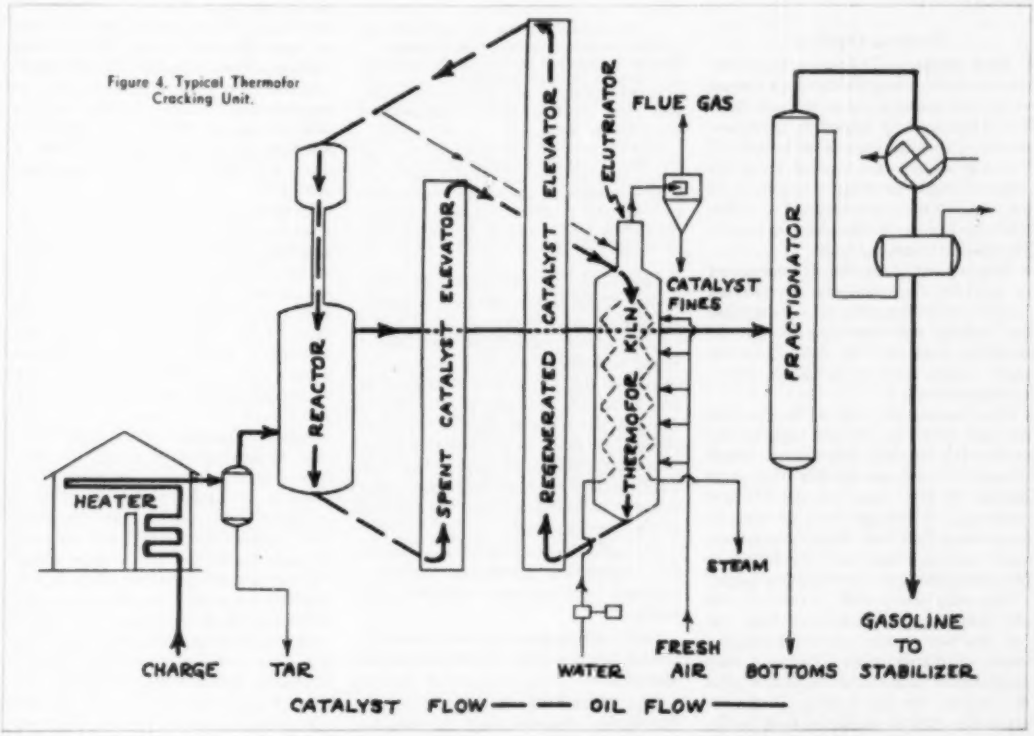

Figure 4. Typical Thermofor Cracking Unit.

7) Adaptability to cocurrent or countercurrent catalyst-oil flow in the reactor.[47]

The process derives its name from the Thermofor-type of clay-burning kiln which is employed as the catalyst regenerating unit.

The Thermofor kiln is licensed for regenerating petroleum decolorizing adsorbents by Max B. Miller Company, 501 Fifth Avenue, New York, under patent rights owned by Socony-Vacuum.[48]

The Thermofor kiln superseded rotary kilns and multiple-hearth burners.[48] It gets its name from "thermophore," a device for controlling heat. As a basis for plant design data, studies were made on the kiln with regard to:

1) Clay flow distribution
2) Heat generation
3) Attrition
4) Diffusion rates in carbon burning

The first commercial installation of the Thermofor kiln for percolation clay burning was made early in 1939 and since that time many additional units have been installed and operated for that purpose. In view of the need for an efficient catalyst-regenerating unit, the adaptation of Thermofor kilns to TCC service offered a logical and attractive course.

Process Outline

Feed stocks to TCC units may consist of any vaporizable distillate having an initial boiling point of over 400° F.[48] This stock is heated in a convection-type furnace from 500° to 850° F. The hot vapors are flashed from the reduced crude in a tar stripper at 15 psi, and then superheated to 900-950° F. Figure 4 illustrates a typical Thermofor cracking unit.

In a typical plant, the oil then passes to an 11½-foot diameter by 30-foot long reactor where the oil vapors enter the bottom and rise against the descending catalyst (in this particular plant—more later of downflow, cocurrent operation).

Clay enters the top of the reactor through a feed leg, 70 feet high, known as the clay leg. It is this feature which is mainly responsible for the great stature of TCC units on the refinery landscape. Although the unit may be more than 200 feet high, it need occupy a ground space of only 1.6 acres, including the gasoline treating plant.

The clay leg is fed in turn by the clay hopper surmounting it. Clay enters the top of the reactor through a series of distribution pipes and then passes over a series of baffles within the reactor. At the bottom of the reactor the clay is steam purged to remove volatiles and it then passes to a depressurizing pot, then to the bottom of the elevator which takes it to the top of the Thermofor kiln.

The reactor operates at 10-15 psi, and temperatures in the reaction zone remain about 850-950° F. The ratio of catalyst to oil varies from 1.0 to 8.0 depending upon design and products desired.[48]

TCC reactors may contain a bed of catalyst varying from 8 to 35 feet in depth.[49] Steam may be introduced with the oil charge, varying in amount from 0-20 percent by weight of the oil charge.[15]

A steel reactor, unlined and externally insulated, may be used. The oil feed grid, the inert gas seal at the top, the steam seal at the bottom with its associated purge system, and the perforated catalyst flow plates complete the reactor.[49]

The effect of reactor operating temperature in Thermofor catalytic cracking has been discussed.[50] Temperatures from 775° to 960° F. were studied in pilot-plant operations. Simultaneously, conversions of from 40 percent to 70 percent by volume were studied at space velocities from 0.5 to 2.0. Of the variables studied, temperature had the greatest effect on octane number of the gasoline. The following general conclusions were drawn from this study:[50]

1) Increased reactor temperature increases octane number, the increase in Research octane number being twice the increase in ASTM number.
2) At constant conversion, the gasoline yield decreases with increased reactor temperature.
3) Dry gas production increases with increase in reactor temperature as do yields of propylene and butylene.
4) Selection of optimum temperature can be made only after an economic study has taken into account a proper balance of all the various factors.

The ratio of catalyst to oil mentioned above is the ratio of apparent volume of catalyst circulated to liquid volume of oil charged per unit time.[15] Space velocity in the TCC process varies from 0.2 to 3.0 and is defined as the ratio of volume of liquid oil charged per hour to apparent volume of catalyst mass in the reaction zone. Note that catalyst-oil ratio is based on total catalyst circulated whereas space velocity is based only on the catalyst in the reaction zone.

The effective control of the various flow quantities mentioned above is handled by automatic control instruments.

Only 12 control instruments are needed for a single 10,000-barrel-per-day unit.[48]

The control of the reactor in the Thermofor process may be summarized as follows:[51]

1) Differential pressure between vapor in and vapor out the top governs the catalyst in and out.
2) A flow transmitter and controller governs the steam to the bottom of the reactor by manual setting.
3) Differential pressure between the top of the reactor and the vapor out controls the flue gas into the reactor near the top.
4) Manually set pneumatic control governs the steam into the reactor near the top.
5) Differential pressure between vapor in and vapor out the bottom controls the vapor out the bottom.

These control valves and the streams they control are illustrated in Figure 5.

Closely allied with the over-all control problem is the measurement of solids in the TCC process.

Rates of solids flow in the Thermofor process are quite low. The vertical downward velocity of the catalyst in the kiln or the reactor is of the order of 6-12 inches per minute.[47] The velocities in the catalyst-carrying lines are in the range of 1.0-2.0 feet per second. Actual catalyst circulation rate in a TCC plant is measured in terms of power required to drive the catalyst elevators.[52] One type of device for the measurement of clay flow has been described in the literature.[53]

Catalyst flow rates are controlled by means of piston-operated butterfly valves operated remotely from the control house. Flow orifices may be used in some lines to control flow. These orifices are eccentrically-drilled plates with the hole at the bottom of the pipe cross-section.[52] Such orifices may be used to control the flow of catalyst in the legs out of the bottoms of the reactor and kiln, according to a recent patent.[54]

Accurate level measurement is necessary in the reactor hopper to prevent overflow into the hot-clay storage tank at high levels or loss of the reactor top seat at low levels. High levels in the kiln hopper must be avoided to prevent filling the catalyst inlet line, which may result in jamming the elevator, and low levels must be prevented to assure smooth kiln operation.[52]

Actual measurement of hopper levels may be accomplished in various ways. One continuous level indicator[52] employs a rotating shaft which is equipped with paddles at the lower end. A second type of level indicator is used on the hot-clay storage tank[52] and is discontinuous in that it tells whether the level is above or below the indicator which is similar to a toggle-switch protruding into the vessel. The use of a series of this latter type of indicator permits approximate location of the level in a vessel. A third type involves suspending the clay hop-

per on coil springs and measuring the downward deflection as an indication of the weight of clay in the hopper.[55] An inductance-coil instrument may be used to transmit the level indication to a remote location.

In the operation of the Thermofor kiln, the inlet-air rate, the inlet-air temperature, and the number of cooling coils in service are subject to control.[47] All cooling coils are usually left in service and air temperatures and air rates to the various zones in the kiln varied to maintain effective control of the kiln. The inlet-air temperature to the kiln is controlled by the addition of heat in a direct-fired air heater.

Catalyst Transfer

The spent clay elevator is of the bucket type with chain drive.[48] It picks up the clay at 850-900°F. The bottom sprocket is mounted on a walking beam to overcome uneven operation. It is welded throughout and driven from the top. Mild alloys resistant to heat stressing are used.

The spent and fresh-clay elevators are unique for their 200-foot length. The catalyst weighs between 40 and 50 pounds per cubic foot and must be handled at the approximate rate of 100 tons per hour for a 10,000-barrel-per-day unit. The elevator consists of two strands of a 12-inch pitch chain with a continuous line of 9-inch projection buckets supported between the chains. The buckets are of 10-gauge heat-resistant alloy steel.

A conveyor speed of 20-25 feet per minute is employed[56] in some units but the speed may run as high as 100 feet per minute in others.[47,52] Low speed is maintained to avoid unnecessary damage and degradation of catalyst.

The elevator casing is gastight and held under several inches of water pressure of flue gas. The top chain shaft is made pressure tight by a conventional packing gland. The lower shaft experiences a 16-inch travel due to expansion and hence employs a conventional packing gland carried in a ground seal plate which closes a slot by spring pressure against a packed frame on each side of the elevator casing. The elevator casing is made up of sliding panel elements lined with insulating block and supported within a tower, independent of the main TCC structure but stayed by it against the wind. The elevator is protected against reverse rotation in case of a power failure by fully-enclosed brakes. The shafts on either end of the elevator are water cooled.

In later TCC elevators, sprockets have been eliminated and replaced by a traction drive between chain and traction wheels.[47] Thus wear is distributed around the rim of the traction wheel rather than being concentrated locally in the sprocket teeth.

At a circulation rate of 100-150 tons per hour and a chain speed of 90-125 feet per minute, about 60-80 horsepower are required to circulate catalyst.[47]

High temperatures and attrition of the 6-mesh clay catalyst were feared for their effects on the conveyor but they have had little effect.

Air under ten inches of water pressure is directed into the clay in the kiln where it burns off the carbon and forms flue gas, some of which is used for the differential seal at the top of the reactor. Residual carbon is 0.2-0.5 percent by weight of the catalyst.

Regeneration temperatures may run from 700-1100°F. Air consumption in standard cubic feet per ton of catalyst circulated may run from 2000 to 20,000.[18] Temperature of the air supply may vary from atmospheric to 1000° F. Residence time in the regenerator is of the order of one hour.

Uncontrolled kiln temperatures would go too high so steam generating coils are provided to control them. A single 10,000-barrels-per-day unit will generate steam as follows:

30,000-45,000 lb./hr. at 450 psi. from the kiln
15,000 lb./hr. at 150 psi. from recycled oil
22,000 lb./hr. at 450 psi. from tar stripper bottoms

The kiln elevator is vented to the atmosphere. This eliminates any reliance on differential pressure valves or other devices to insure that hydrocarbon vapors from the reactor will not enter the combustion zone.

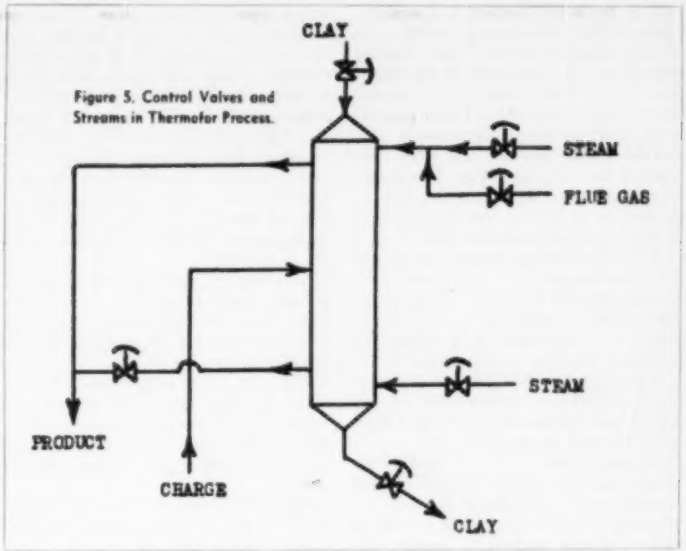

Figure 5. Control Valves and Streams in Thermofor Process.

The spiral-finned type of Thermofor kiln[50] may be considered as representative of early practice, although a number of special types have since been developed for catalyst regeneration. With this type, the main burning zone of the kiln is filled with a bundle of spiral-finned tubes. These tubes are designed to provide air passages up under the spiral fins, while catalyst moves slowly down over and around the fins. Molten salt, steam, or other heat-transfer media may be circulated through the finned tubes to control burning and to prevent the catalyst from attaining heat-damaging temperatures. The fins thus provide both air passages and extended heat-transfer surface. It will be noted that the regeneration of the catalyst is controlled without the recycling of flue gas or catalyst in the regenerating system. Internal kiln construction is 4-6 Si-Cr steel, although the kiln body is plain carbon steel.[48]

The regenerator kiln consists of a series of alternate burning and cooling zones. Air is admitted to and fumes are removed from each burning zone, and between the burning zones; catalyst is cooled by generation of steam in the cooling coils.[49] This zone-type construction enables the removal of materials other than pure carbon from the catalyst at low temperatures of 875-975°F. Thus water vapor and any oxides of sulfur are removed before high-temperature combustion occurs, at which latter point their presence would result in loss in catalyst activity.[47]

Recent TCC kilns feature elimina-

tion of the angle packing and replacement of the salt cooling system with direct steam-generating coils. Forced circulation of feed water is employed and excess feed water is circulated above that required for steam generation. Scale deposit in the tubes is minimized by the fact that the tubes thus operate flooded with water. The steam-water mixture leaving the kiln is flashed in a tank at the water pump suction to produce plant steam.

The kilns in these plants are square in cross-section and are lined with suspended tile. Special techniques have been worked out for the application of suspended wall linings to catalytic cracking installations.[59,59a]

Fines leaving the kiln are removed in an elutriator incorporated in the upper part of the kiln. Material finer than 14-mesh is removed here.

Regeneration has been studied in detail, percent carbon burned plotted against percent oxygen in the flue gas showing a rapid rate at first, becoming slower as the carbon is burned off. Most kilns have 7-10 separate burning zones as described above. A detailed heat balance of a TCC plant has been published[59] and is of interest in studying kiln operation.

A single-zone laboratory kiln was set up in the course of a systematic study of the variables in the combustion of coke deposit on Thermofor catalyst.[61] The following main factors were evaluated:

1) Coke deposit
   a) Initial carbon concentration on the catalyst
   b) Fraction of the initial carbon remaining on the catalyst
   c) Relative proportions of carbon and hydrogen in the coke
2) Operating conditions
   a) Temperature
   b) Air rate
   c) Oxygen concentration
   d) Catalyst volume in burning zone

An empirical equation relating oxygen concentration, catalyst temperature, and carbon concentration was developed.[61]

Catalyst Development

In adapting the Thermofor kiln to cracking plant service, it was necessary to provide a catalyst having flow characteristics similar to the granular percolation clays. This catalyst is in the form of granules or pellets ranging from 4-60 mesh. Improvements in manufacturing methods have resulted in the production of coarser and more rugged types of clay catalyst and the materials now used commercially fall in the range of 4-10 mesh in size.[62]

Catalyst particle size was chosen between 0.1 and 0.2 inches diameter, which was large enough to be manufactured conveniently, of proper size to permit a ready flow of vapors through a bed and at the same time permit proper diffusion into the individual particles. The data of Chilton and Colburn[60] were used to calculate pressure drop through the bed. Detailed studies of pellet flow through orifices (the catalyst outlet at the bottom of the reactor e.g.) were made using colored pellets in a transparent reactor model.

Satisfactory catalysts must possess proper catalytic activity, and at the same time be sufficiently rugged to resist mechanical breakdown in the cracking plant.

Catalyst consumption may be reduced to less than 0.25 pound per barrel of oil charged. In actual cost this is less than one cent per barrel of charge with clay catalyst at $60 per ton.

Catalyst "make-up" should be carefully distinguished from catalyst "loss."[57] The latter is purely a mechanical problem; whereas the former is a figure arrived at on the basis of an economic balance. Catalyst makeup is the total of the catalyst added to the system to make up mechanical losses and that added to replace catalyst withdrawn from the system to maintain optimum catalyst activity. The two figures may be quite different. Mechanical loss may be held down to 0.1 pound catalyst per barrel of oil charged but optimum catalyst replacement rate for one typical example[57] was calculated to be 0.8 pound catalyst per barrel of oil charged for conditions of maximum profit.

A laboratory method has been developed for the determination of the activity of cracking catalyst, a standard method giving an "activity index" for a given catalyst.[63] This is valuable in that it assigns a meaningful numerical value to what would otherwise be a rather vague concept.

The use of clay catalysts offers certain advantages, including their availability in large quantities at relatively low cost. The general advantages of using the more active, although more expensive, synthetic catalysts in place of the clay catalysts have long been recognized. Until recently, however, the available synthetic materials have not had suitable physical characteristics, notably with respect to attrition resistance, to permit their use in TCC units.

This prompted Socony-Vacuum Oil Company to undertake extensive research work on synthetic catalysts. The ultimate result of this work was the invention of a new material, known as the "bead" catalyst, which is unique in shape and outstanding with respect to both physical ruggedness and catalytic activity. This catalyst[62] derives its name from the fact that it is produced in the form of small spherical particles resembling translucent glass beads.

An individual bead with a diameter of ⅛ inch will support an average load of about 200 pounds, and a mass of beads in a column will support a load of about 3000 psi. before crushing. In a jet test where the beads were carried in an air stream at a velocity of 100 feet per second and impinged against a vertical steel plate, they showed no breakage and only 3 per cent wear after passing through 90,000 cycles.

The plant for the manufacture of bead catalyst was completed at Socony-Vacuum's Paulsboro refinery in May 1944.[64] This was two years from the date when the first few experimental beads were produced in the Paulsboro laboratory.

In March, 1945, Socony-Vacuum reduced the price of bead catalyst from 25 to 18 cents per pound[65] and to 12 cents per pound in 1947.[43] It is interesting to compare this with the figure of 4 cents per pound for clay catalyst as purchased f.o.b. plant.[66] Since the clay catalyst as purchased contains about 20 percent moisture, this amounts to about 5 cents per pound on a dry basis. This in turn may be compared with 20 cents per pound for Houdry synthetic fixed-bed catalyst, making the new bead catalyst the least expensive pure synthetic cracking catalyst ever produced.

A thorough comparison of the various aspects of using bead vs. clay catalysts has been presented by Evans.[66] Increased yield of motor gasoline under the same general operating conditions and lessened sensitivity to poisoning by sulfur and nitrogen compounds are features of the use of bead catalyst.

The adverse comparison of direct cost per unit weight for bead catalyst vs. clay catalyst is counterbalanced by these two factors and by the reduced attrition loss of the bead catalyst. The maintenance of high activity level in the bead catalyst, together with the low attrition rate, result in a catalyst replacement rate 1/3 of that required for clay catalyst. Thus decreased makeup counterbalances increased cost per unit weight and permits the bead catalyst to assert itself in an economic comparison.

The actual technical details of the manufacture of the beads have been covered by patents.[67,68,69,70,71,72]

The physical properties of commercial bead catalyst may be summarized as follows:[61]

Density, g./cc.	
Apparent	0.70
Particle	1.10
Substance	2.42
Surface area, sq.m./g.	420
Pore volume, cc/g.	0.50
Average pore diameter, °A	47
Average particle diam., mm.	3
Particle size range, Tyler Screen Scale	4-12

New TCC Developments

Equipment modifications have been introduced into newer TCC units.[62] As previously mentioned, reactors were originally designed with an internal baffle system to provide high throughput capacity with efficient contact between oil vapors and catalyst. However, with this design the proportion of the total reactor volume occupied by the catalyst is reduced by the presence of the baffle system. Moreover the quantity of the catalyst in the unit cannot be varied to provide maximum flexibility. Thus, although reactors of this type can be designed to operate at any specified space velocity, they cannot be operated below the designed space velocity without decreasing the oil throughput rate.

Recent catalyst developments have made it possible to design reactors of high throughput which require no baffle system for obtaining intimate contact between oil vapors and catalyst. The elimination of internal baffling increases the effective volume of the reaction zone and permits wide flexibility with respect to space velocity. All recent TCC reactors are of this improved type. As an added feature of flexibility, these reactors can be adapted to either countercurrent or cocurrent flow.

The TCC units completed in February, 1944, by General Petroleum Corporation at Torrance were the first to utilize these solid-bed reactors.

Newer TCC reactors without baffles can be operated at space velocities down to ¼ the present at the same oil rate.[63]

One of the latest developments in TCC cracking is the liquid-charge technique.[73] Partially-vaporized stocks containing as much as 50 percent liquid can be processed by the use of a catalyst circulation rate of 100-150 tons per hour of catalyst in a 10,000 barrel-per-day plant. Heavy charge stocks which may be almost 100 percent liquid may be processed satisfactorily by doubling the catalyst circulation rate. These higher catalyst-to-oil ratios are necessary to maintain the heat balance in the reactor, and to hold coke distribution on the catalyst down to a value desirable both from the standpoint of catalyst activity and from the standpoint of regulation of heat liberation in regeneration. In general, the cracking of heavy feed stock

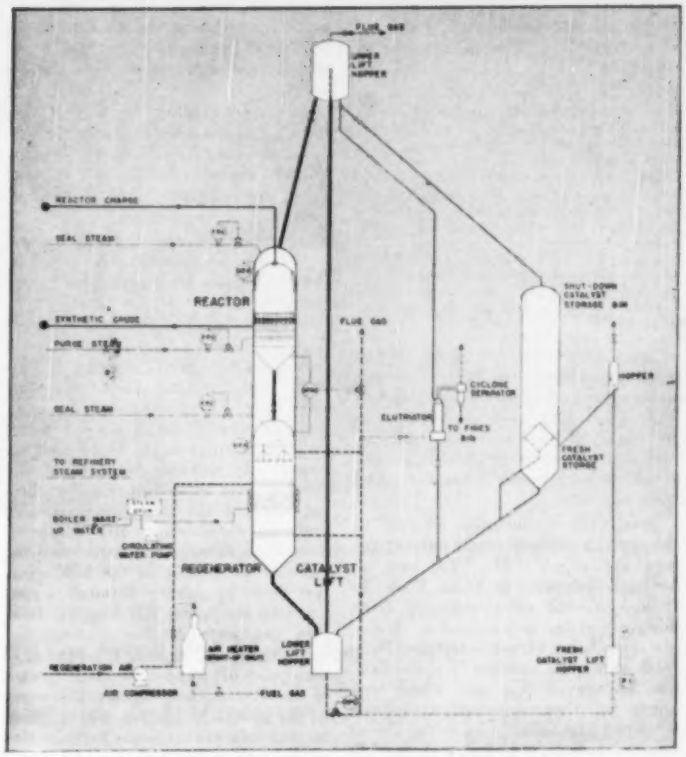

Figure 6. Flow Diagram of Houdriflow Catalytic Cracking Process.

results in heavier coke deposition than when feeding a lighter stock. The catalyst circulation rate might be regulated to give 2.5 per cent by weight of coke on the catalyst as a typical figure.[73]

The concurrent, solid-bed, downflow type of reactor is used in the application of the liquid-charge technique. The liquid or semi-liquid feed is introduced at the top of the bed through a fog-nozzle distributor and the vapors are disengaged from the catalyst, leaving the bottom of the reactor by inverted troughs which pick vapors up from the underside of the troughs and conduct them to a manifold as the catalyst flows freely over the troughs and out of the reactor. It has been shown, in experimental work, that the cracking reaction starts as soon as the oil spray hits the catalyst. Seventy-five percent conversion of the charge to materials lower boiling than the initial boiling point of the charge was experienced in the first 12 percent of the reaction zone.

In the development of the liquid-charge technique, pilot-plant operations were conducted over the following ranges of operating variables:[73]

Oil inlet temp., °F.	700-950
Catalyst inlet temp., °F.	900-1100
Catalyst/oil ratio by vol.	1.8-6.0
Space velocity, vol./vol./hr.	0.4-6.0
Steam, % by wt. in feed	5-10
Pressure, psig.	10

Typical operating conditions using this technique and bead catalyst include coke deposits in percent by weight on the catalyst ranging from 6.4 to 8.5 percent.[73] It is interesting to compare these figures with the limit of 1.1 per cent by weight in the Houdry fixed-bed process[29] where regeneration temperature and regeneration time are the limiting factors.

The development work mentioned above was carried through to successful commercial application in the Paulsboro refinery of Socony-Vacuum. The details of the mechanical setup used in the commercial plant have been presented in the literature.[74]

The catalyst-oil vapor disengagers were modified in the commercial unit into a device resembling a multitude of umbrellas which gathered the vapors up under the umbrellas and transmitted them down hollow handles to a vapor manifold space while the catalyst streamed over these "umbrellas" like rain.

Commercial operation of a TCC

unit on partially-vaporized charge stocks has resulted in the drawing of several conclusions as to this type of operation:[74]

1) Changeover to this type of operation, at a cost of only 1 percent of the initial plant investment, is quite attractive from an economic standpoint.

2) Ideal isothermal reaction conditions may be more closely approached by this type of operation since all the heat in the incoming catalyst contributes to catalyst bed temperatures in concurrent operation.

3) Better heat utilization results in higher average reactor temperatures for given oil and catalyst-inlet temperatures, giving higher octane-number gasoline products.

Investment costs per barrel of gasoline are stated[64] to be lower than those of any other process. The cost of TCC processing amounts to 7 cents per barrel of gas oil charge[65] and this includes operation, supervision, fuel, steam, power, water, laboratory, and maintenance.

Small Thermofor units adapted to the specific needs of small refiners are now available.[1,15] The TCC unit of Leonard Refineries at Alma, Mich., is typical of such units, charging 3000 barrels per day to the reactor. A single split-bucket elevator carrying both fresh and spent catalyst is a mechanical feature of this unit which operates on the cocurrent, downflow, solid-bed principle. In an initial three-months' operating period, a stream efficiency of 95.8 per cent was maintained. It is estimated that similar units could be constructed for $250-$300 per barrel per day of reactor charge capacity.[75] This is estimated to be less than the cost of new thermal cracking facilities at $300 per barrel per day.[76]

Houdriflow Catalytic Cracking Process

The Houdriflow catalytic cracking process[77] is designed to retain the desirable features of the conventional TCC process and to incorporate a number of improvements to obtain greater flexibility and lower cost. Among the improvements is a new method for moving catalyst, the use of higher catalyst to oil ratios, and a simplified kiln. In addition, physical arrangement of the vessels is more compact.

Flue gas lifting of catalyst is more economical than the bucket elevators, reduces the number of mechanical devices, and provides a wider range of catalyst circulation rates.

Higher catalyst to oil ratio permits considerable flexibility of operation, since liquid, partially vaporized, or vaporized stocks can be processed without difficulty. Liquid or partially vaporized stock simplifies feed preparation equipment, because a major portion of the reaction heat can be obtained from catalyst entering the reactor.

Increased catalyst circulation permits use of the simplified kiln. In previous designs, 7 to 10 zones were required, whereas one or two burning zones are sufficient in the Houdriflow process.

To minimize catalyst handling and to reduce the ground area required, the reactor has been superimposed on the kiln.

From the upper lift hopper (Figure 6), regenerated pelleted or bead catalyst flows by gravity through the reactor seal leg into the reactor, and downward through the reaction zone, through vapor-disengaging and steam-purging sections in the bottom of the reactor. By way of the seal leg, the catalyst then flows into the distributing head of the kiln, which insures uniform distribution, and continues downward through the regenerator.

From the bottom of the kiln, catalyst flows by gravity through a seal leg into the lower lift hopper. It is then transported by flue gas from the kiln through a vertical lift pipe into the upper lift hopper. A small stream of catalyst is continuously by-passed to the elutriator for removal of fines to maintain the average particle size of the catalyst desired.

Oil is charged to the reactor through an injection nozzle, centrally located in the top of the reaction zone and inside the annular curtain of flowing catalyst. The mixed-phase feed is atomized by the injection nozzle and directed onto the hot catalyst, which completes the vaporization and brings the temperature of the vapor-catalyst mixture to the desired level for reaction. Then the vapors pass downward concurrently with the catalyst through a solid-bed reaction zone. Cracked vapors leave the reaction zone through a catalyst-vapor disengager in the lower part of the reactor and are conducted to a conventional fractionation and recovery unit.

The seal at the top of the reactor, to prevent the escape of hydrocarbon vapors up the seal leg, is maintained by a small flow of steam regulated by a recording flow controller. Similarly, purge steam, in the bottom of the reactor prevents escape of cracked vapors through the seal leg into the regenerator.

Spent catalyst regeneration air is supplied by a blower at about 10 psig., which bypasses the air heater used for startup. The air enters the kiln through a channel-type distributor. Upper burning zone flue gases flow from the top of the regenerator and enter the main flue gas duct. From the lower burning zone, the flue gases flow from the bottom of the regenerator by way of a channel type collector and also enter the main flue gas duct. Regeneration heat is removed by a bank of cooling coils in the kiln as steam to maintain the desired catalyst temperature.

Flue gas for lifting catalyst flows into the lower lift hopper through a flow controller, and carries the catalyst up the lift pipe to the upper lift hopper. The gas is vented to the atmosphere from this point.

(End of Part II. Part III will appear in an early issue.)

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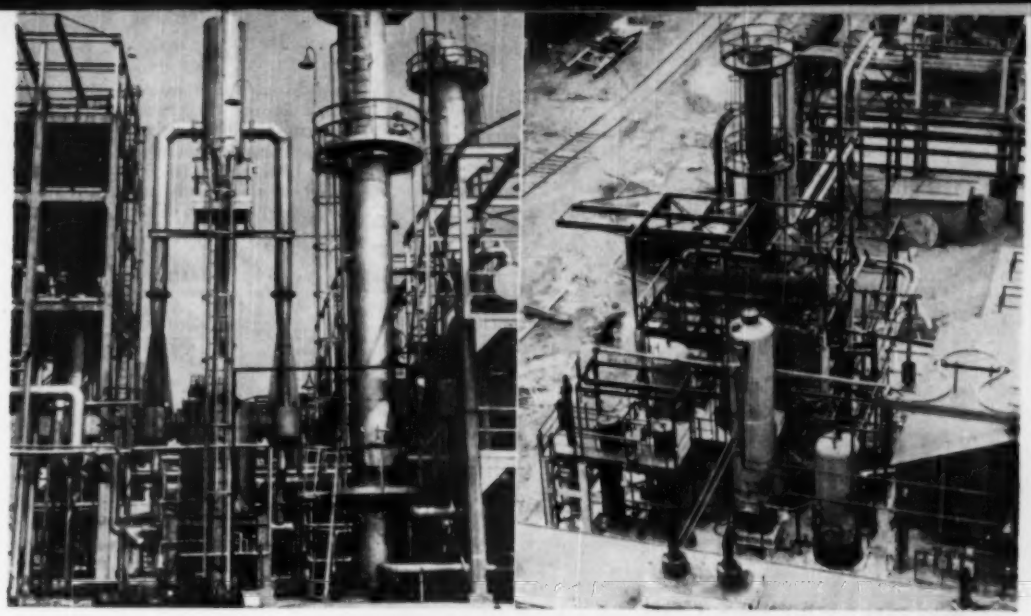

Above, left: Refrigeration Unit Used to Control Head Temperature on the Deethanizer Tower. Above, right: New Liquefied Petroleum Gas Unit at Sinclair's Marcus Hook Refinery.

Refinery LPG Unit Employs Steam Jet Vacuum Refrigeration

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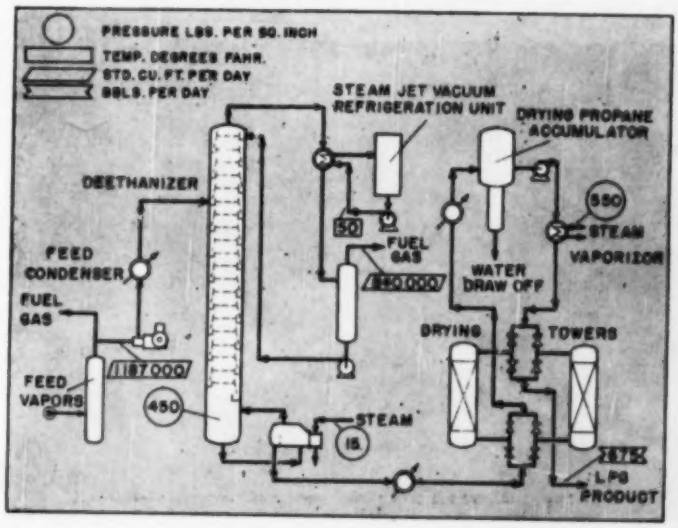
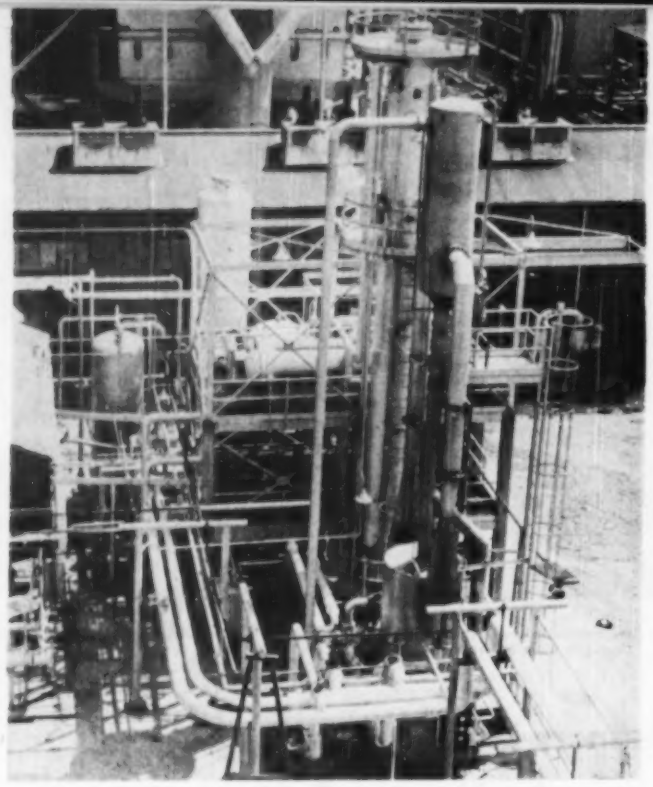
SINCLAIR Refining Company has placed on stream at its Marcus Hook refinery, a new unit with a capacity of 1100 barrels per stream day of liquefied propane gas. Construction of this unit, which was designed and built by Sinclair personnel, was started on July 1, 1949, and since going on stream last March, it has been operating continuously. Currently it is producing an extremely dry, low olefinic content liquefied petroleum gas product which meets all NGAA specifications for commercial propane.

This operation was undertaken to meet the ever increasing demand for liquefied petroleum gas in the North Atlantic seaboard area. Heretofore shipments of LPG to this market were made from the Mid-Continent area, but this proved to be economically unsound due to high freight rates and delays in transportation. Hence it was decided that a source of supply nearer

ONE OF THE interesting features of this refinery LPG unit is the application of steam jet vacuum refrigeration. While refrigeration in the recovery and fractionation of light hydrocarbons is employed in many plants, the use of steam jet refrigeration is unusual. Critical evaluation of economic and operating factors indicated that the selection of this refrigeration system would be justified here.

Figure 1. Flow Diagram, Propane LPG Production.





Elevated View of Liquefied Petroleum Gas Plant Showing Refrigerator Condensor in Foreground and Deethanizer Tower immediately in Rear.

to points of consumption was necessary.

In this new plant the butanes and lighter hydrocarbons are recovered from cracked distillated stabilization operations and treated in sequence with diethanolamine and caustic solutions for the removal of hydrogen sulfide and mercaptans. This hydrocarbon stream is then subjected to a high-pressure (1000 psig.) catalytic polymerization operation wherein 85-90 percent of the propylene-butylene content is reacted. The propane and lighter hydrocarbons stream from the polymer de-propanizer are charged via gas-driven reciprocating compressors to a 20-tray deethanizer which fractionates out 85-90 percent of the propylene-propane content of the charge for LPG sales. The composition of feed, overhead and bottom streams of the deethanizer operations are as shown in Table 1.

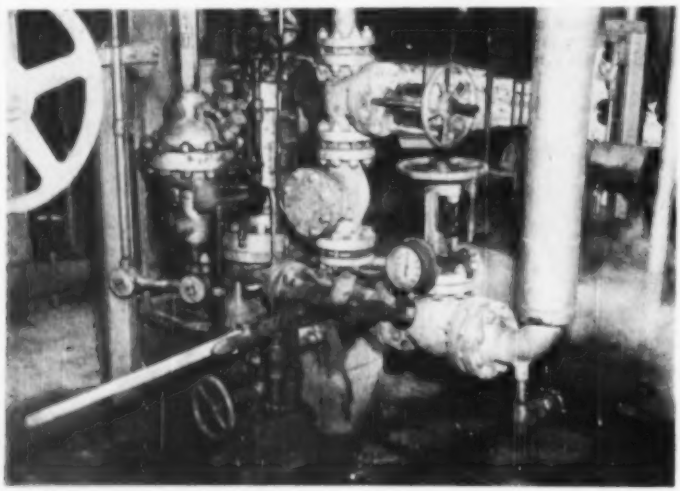
TABLE 1

	Feed Mol Percent	Release Gas Mol Percent	LPG Liq. Percent
Methane	4.6	10.2	....
Ethylene	4.7	10.5	....
Ethane	29.9	66.5	0.5
Propylene	4.6	2.0	4.0
Propane	56.2	11.8	95.5
	100.0	100.0	100.0

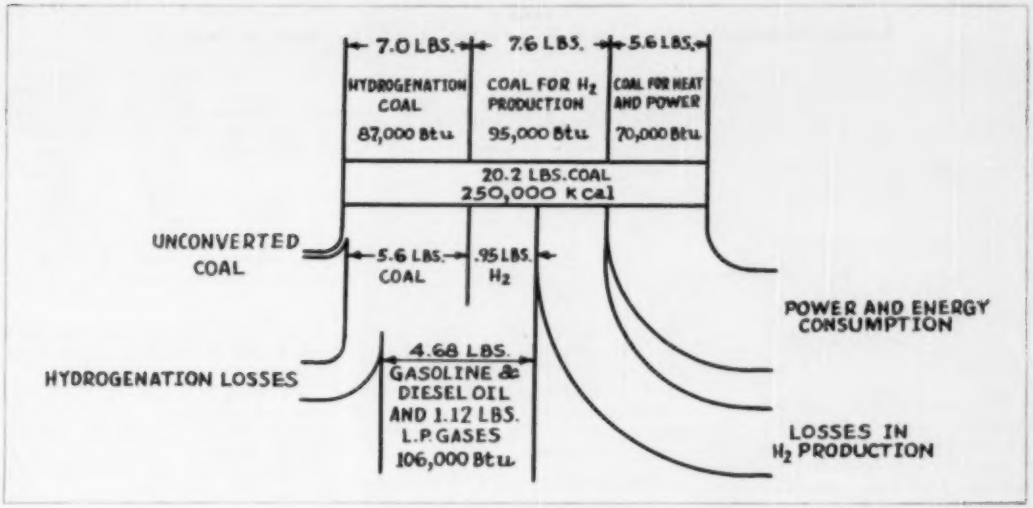
A 126-ton-per-day capacity steam jet refrigeration unit is used during the warmer months of the year to provide 50° F. cooling water or the reflux condenser of the deethanizer. A stuffing-boxless type centrifugal pump has given trouble free operation in this rather difficult deethanizer reflux service. In order to prevent "frosting" of the overhead release gas pressure control valve and the downstream line from the same, an all welded shell and tube steam heater was installed between the gas outlet from the reflux accumulator and this gas release valve. LPG, the bottoms product of the deethanizer column, flows on level control from a cooler through an activated alumina drying tower and thence into "bullet-type" storage vessels. Three such vessels, each of 600-barrel capacity, have been provided along with tank car and truck loading facilities.

Regeneration of the alumina is accomplished by stripping the adsorbed water from the drying beds with 350° F. propane vapors. A closed system is empfoyed from the regeneration of the alumina beds and consists essentially of a propane accumulator, a small centrifugal circulating pump, a vaporizer in which 550-psig. steam is used for vaporization and superheating and water cooled exchanger to condense the propane and water vapor effluent from the drying bed. The water desorbed from the drying bed separates out in the accumulator and is withdrawn from a well at the bottom of the accumulator. The towers are currently on a 24-hour drying cycle with regeneration now being accomplished in 6-12 hours.

General design and current operations of this unit are as shown in the flow diagram, Figure 1.



View Showing Vapor Seal Pump for Handling Ethane Reflux in Deethanizer.



Heat Flow Sheet for Bituminous Coal Hydrogenation

High-Pressure Hydrogenation Of Carbonaceous Matter

PART VIII

THE INTEGRATED PROCESS

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IN THE preceding articles, the technical status, choice of operating conditions, and process limitations of the two fundamental phases of the hydrogenation process have been discussed. In its present state of development, high-pressure hydrogenation represents a technically advanced process for the manufacture of a variety of hydrocarbon products and oxygenated chemicals from the entire gamut of carbonaceous raw materials accessible to exploitation, ranging from coal and coal tars to shale oils and petroleum stocks. It has been seen that, except in special cases where an unusually favorable raw material is available, the high-pressure conversion to lighter hydrocarbons (such as gasoline and diesel oils) must be carried out in two successive operations—hydrogenation in the liquid phase followed by final processing in the vapor phase.

The success of the operation depends, of course, on thorough integration of the two high-pressure phases, not only with each other, but also with the remainder of the plant—power production, gasification, water gas conversion, gas purification, coal preparation and grinding, paste preparation, product distillation, low-temperature separation of the hydrocarbon gases, methane reforming, etc. The proper design and operation of these ancillary units may influence the economics of the process as profoundly as the operation of the high-pressure core of the plant.

***HIGH-PRESSURE** hydrogenation is a valuable process for the manufacture of premium products from low-grade carbonaceous stocks. Its importance is associated particularly with the production of synthetic fuels.*

This last article in a series of eight discusses over-all requirements and performance of high-pressure hydrogenation applied to various raw materials. Consideration is given to the all-important economics and thermal efficiencies of the process.

Requirements for High-Pressure Operation

Over-all requirements for high-pressure hydrogenation for the production of motor fuel from a number of typical raw materials have become available[1] and are listed in Table 1. It will be noted that operating requirements and losses increase as a direct function of the degree of hydrogenation of the raw material.

Thermal Efficiency of the Process

Thermally, the conversion of carbonaceous matter of high molecular weight into liquid fuels is highly inefficient. In the case of high-pressure hydrogenation of bituminous coal for the manufacture of gasoline—thermally the poorest instance of high-pressure conversion—only about 30 to 50 (55?) percent of the total entering heating values are recovered in usable form. In other words, a sizable portion of the available fuel value is sacrificed for a qualitative improvement in the product.

By definition, the thermal efficiency of coal hydrogenation is the heating value of useful products including gasoline, liquefied petroleum gases, and salable residue, divided by the heating value of the coal or fuel required to produce the products, as well as all the requirements for steam, power, oxygen, and other utilities, time 100.[2] Thus:

TABLE 1

Summary of Hydrogenation Data for the Production of Motor Gasoline from Various Raw Materials

	Raw Material Requirement, Ton Anf Material Ton	H_2 Consumption Ton Ton Gasoline	Surplus Hydrocarbon Gas Make Ton Ton Gasoline	Oil Losses in Sludge Kiln, etc. Ton Ton Gasoline	Unconverted Solid Residue Ton Ton Gasoline	Liquid Phase Reaction Volume Requirement for 200,000 Tons Year Gasoline	Vapor Phase Penetration Stall Reaction Volume Requirement for 200,000 Tons Year Gasoline	Vapor Phase Splitting Hydrogenation Reaction Volume Requirement for 200,000 Tons Year Gasoline
Vaporizable Middle Oil, Distilled from Petroleum	1.06	.032	.09				580 ft.^{3}	965 ft.^{3}
Vaporizable Middle Oil, e.g. from Coal Tar Distillation	1.07	.097	.09				1450 ft.^{3}	1030 ft.^{3}
Brown Coal Tar Plus Associated Scrubber Oil	1.20	.081	.23	.03		1350 ft.^{3}	1450 ft.^{3}	965 ft.^{3}
Petroleum Residuum (Containing 11 Percent Hydrogen)	1.20	.072	.23	.01		1610 ft.^{3}	580 ft.^{3}	1000 ft.^{3}
Coke Oven Tar	1.28	.178	.23	.03		2190 ft.^{3}	1045 ft.^{3}	1030 ft.^{3}
Lignite	2.07	.198	.41	.18	.03	2700 ft.^{3}	1125 ft.^{3}	1480 ft.^{3}
Bituminous Coal (10,300 Psi. Pressure Process)	1.63	.236	.43	.08	.07	3300 ft.^{3}	1045 ft.^{3}	810 ft.^{3}
Bituminous Coal (4,000 Psi. Pressure Process)	1.77	.256	.52	.11	.14	3400 ft.^{3}	1045 ft.^{3}	810 ft.^{3}

$$\%\text{heat efficiency} = \frac{\text{heating value of products} \times 100}{\text{heating value of coal or fuel}}$$

The most important fuel-consuming operations in the hydrogenation plant are hydrogen production, power generation, and hydrogenation proper. The last-named of these operations refers in the first place to the actual high-pressure processing but also includes such secondary power-consumers as residue processing, distillation, coal grinding, etc.

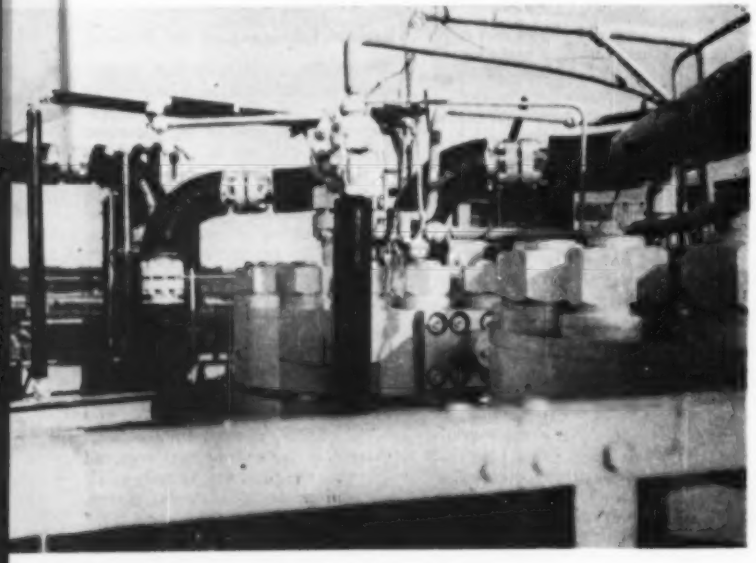
From a thermal point of view, the most wasteful operation in the entire process is the production of purified high-pressure hydrogen. The efficiency of this operation depends to a large extent on the method of water gas generation.

Water gas—the primary source of hydrogen—can be produced from methane (natural gas where available and Hygas mainly derived from the liquid phase) by reaction with steam, with a thermal efficiency ranging between 70-75 percent.[1] Special conditions may lead to a preference of the oxygen splitting process of methane which can be carried out with an efficiency of nearly 80 percent.[2]

The principal source of water gas in a normally constituted coal hydrogenation plant is coal or coke. Thermal efficiency of a standard coke-fired water gas generator is approximately 69 percent (including waste steam generation) and 61 percent (excluding waste steam generation).[4] An efficiency of 59 percent has been reported for the operation of a continuous generator of the Pintsch-Hillebrand type.[5]

Oxygen-fired continuous coal gasification units, which can operate with a wider variety of fuels, exhibit comparable thermal efficiencies. Denig[6] reports an efficiency of 60-65 percent for the Koppers coal dust gasification unit.

Converter Covers and High-Pressure Piping



An additional 7-8 percent of the input heat is recovered usefully in the form of steam.

According to Denig, oxygen-driven, coke-operated Kerpely gasifiers are capable of gasifying solid fuels with the highest degree of thermal efficiency. As much as 88-90 percent of the input heat can be recovered as chemical heat of the product gas. Waste steam generation raises the overall efficiency by an additional 2-3 percent.

Skinner and co-workers[2] estimate that compressed hydrogen can be produced from water gas with an efficiency of about 61-62 percent. As is to be expected, very appreciable thermal losses—estimated at 77 percent—occur in the mechanical compression from atmospheric pressure to 10,300 psi. Because of the volumetric relationships involved, it has been suggested that much may be gained in compression efficiency by generating the water gas under pressure of, say 300 psi. The basic difficulty underlying any such pressure process for the production of water gas is, however, the unavoidable tendency toward methane formation which reduces the water gas yield materially unless very high temperatures are employed.

Little need be said in this place about the efficiency of power production which, incidentally, influences the efficiency of high-pressure hydrogenation quite significantly. Modern power plants may be expected to generate electricity from coal with a thermal efficiency ranging from 37-41 percent.

The efficiency of the hydrogenation proper depends to a great extent on the method of heat regeneration. In the case of a plant hydrogenating bituminous coal with comparatively poor regenerative heat recovery, Wilde and Schappert[7] estimate a thermal efficiency of 49 percent for the high-pressure stage (one liquid phase, two vapor-phase stages), if no account is taken of the fuel value of the kiln residue. By taking account of this by-product, the thermal efficiency is raised to 54 percent.

Skinner and co-workers[2] express the opinion that the efficiency of hydro-

genation proper (of bituminous coal) can be raised to 73.2 percent by providing such engineering features as paste heat regeneration, the substitution of a special booster converter for the gas-fired preheater of the liquid phase, operation of the vapor phase in a single stage, and recovery of the heat of reaction in the vapor phase by the use of external coolant instead of the cold gas injection which is now being practiced universally.

According to these authors, the practical limit of over-all thermal efficiency in hydrogenation of bituminous coal is probably in the neighborhood of 55 percent. This compares well with the thermal efficiency of 42.3 percent reported by Wilke for an existing modern hydrogenation plant.[8]

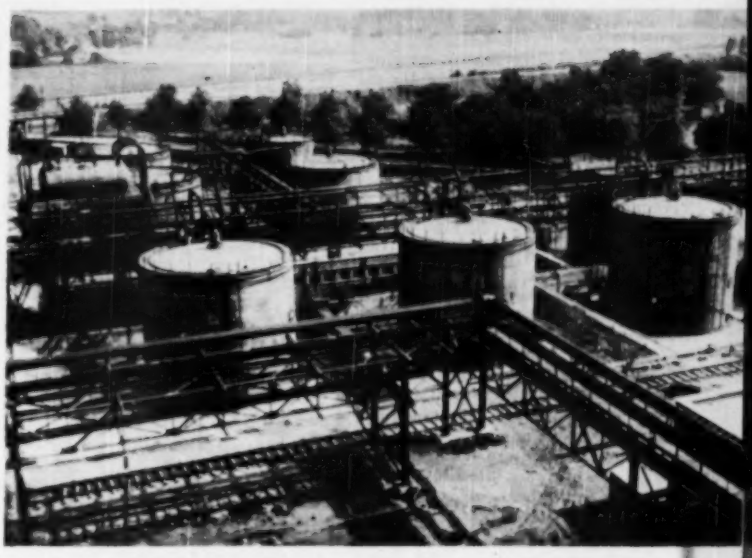
Of carbonaceous substances which may serve as practical raw materials for industrial high-pressure hydrogenation, bituminous coal and its high-temperature distillation products have the lowest hydrogen per carbon ratio and consequently require the largest quantity of hydrogen per unit weight of product. As a corollary, the thermal efficiency of bituminous coal hydrogenation is particularly poor. Efficiencies as high as 60-65 percent are obtained in the hydrogenation of light, thermally cracked tars in existing plants. In this case, additional thermal savings are due to the absence of a paste preparation step and the presence of an only insignificant residue processing operation. Conversion efficiencies in plants operating with suitable petroleum fractions are presumably even higher.

Steel Requirements

A complete breakdown of steel requirements (Table 2) has become available for a plant producing 4500 barrels per day aviation gasoline from lignite.[9] The liquid phase is operated at 10,300 psi. A presaturation and splitting stage are provided at 4400 psi. Water gas is produced in a Winkler gasification unit.

TABLE 2

	Steel Requirements, Tons
1. Gasoline Plant:	
1) Coal Crushing and Grinding	2,080
2) Stalls	14,200
3) Machine House Installations	5,800
4) Residue Processing	3,080
5) Distillation and Tankage	4,840
6) Misc. Outside Lines, etc.	5,000
Total	39,000
2. Gas Plant:	
1) Hygas Splitting, Desulfuring and Conversion	8,500
2) Winkler Water- and Fuel-Gas Plant, Including On-Production	5,800
3) Compressors	2,860
4) Gas Cleaning of CO and CO_2	3,620
5) Gas Tanks	2,750
6) Miscellaneous Pipe Lines, etc.	1,680
Total	25,180
3. Power Production:	
1) Power Plant	23,000
2) Water Works	1,870
Total	24,870
4. General and Auxiliaries:	
1) Power Distribution	2,620
2) Other Auxiliaries	8,380
Total	10,900



Middle Oil Storage Tanks in High-Pressure Hydrogenation Plant

Cost of Hydrogenation Processes

Much unsupported and some calculated information has been presented during the past few years on costs of high-pressure hydrogenation plants. The only available cost information on existing plants is related to German units. Unfortunately, such information cannot be directly translated into American terms in view of the different cost scales which apply to labor, raw materials, and equipment. Various conversion scales have been suggested varying from $0.24 per reichsmark (the 1930 official rate of exchange) to $0.40 per reichsmark (the 1938 official rate of exchange) to $0.60 per reichsmark. In view of today's high construction costs, these conversion rates are probably unduly low. A large number of cost comparisons for similar plants constructed in the United States and Germany have led this writer to the conclusion that a fair conversion factor from German 1938 plant costs to American costs in February, 1949, varies between $0.80 and $0.95 per reichsmark.

In the light of this qualification, Table 3 presents German plant costs.[10] Probably their chief significance rests in the comparative value of the various components of the integrated hydrogenation plant.

A cost estimate has been prepared by the U. S. Bureau of Mines for a plant producing 10,000 barrels per day of heavy fuel oil by various processes.[11] Plant costs in Table 4 have been estimated for the process involving gas production by coal gasification and conversion in the liquid phase only followed by filtration and flash

TABLE 3

German Plant Costs

(All Figures in 1000 RM)

Plant	Welheim	Gelsenberg	Bohlen
Capacity, Tons per Year	143,000	440,000	275,000
Raw Material	Bit. Pitch and Tar	Bit. Coal	Lignite Tar
Pressure	10,300/10,300	10,300/4,400	4,400/4,400
I. Hydrogen Production, Purification, Compression	20,000	40,000	17,100
II. Paste Preparation, Residue Processing	1,350	12,000	400
III. High-Pressure Stalls and Accessories	20,350	63,150	16,000
IV. Distillation, Rich Gas Purification, Storage, Phenol Recovery	8,900	27,000	10,600
V. Drainage, Pipe-Bridges, Electrical, Cooling	12,000	34,300	12,800
VI. Stores Amenities	9,150	22,000	15,200
VII. Power Plant		42,400	
Note: Year of Construction	1940	1939	1935
German Cost Index	148	128	100

stripping of the residue. The hydrogenation is carried out at 10,300 psi.

On this basis, the Bureau estimates that fuel oil can be produced for the cost shown in Table 5.

Another, less detailed estimate (Table 6) also due to the Bureau of Mines[12] has been presented for the production of 30,680 barrels per day total products (of which 22,100 barrels are gasoline) from low-ash, high-volatile bituminous coal. The process is carried out at 10,300 psi. in both phases.

Taking coal at $3.56 per ton, the Bureau calculates gasoline production costs of 16.9 cents per gallon if no credit is taken for phenol sales. Of this total 5.5 cents is due to capital costs and taxes. If a credit of 10 cents per pound phenol and 8 cents per gallon L.P. gases is taken, manufacturing costs for gasoline are reduced to 9.3 cents per gallon. Disallowing the phenol credit, the final cost is estimated at 13.3 cents per gallon gasoline.

Farish estimates that a 2950 barrel per day hydrogenation plant for the production of gasoline from bituminous coal will call for a plant investment of $12,800 per daily barrel (1942 prices) and will result in production costs of 22.6 cents per gallon gasoline.[13] Cost breakdown for this estimate is incomplete.

Two early papers by Russell and co-workers[14,15] on the economics of combined hydrogenation and cracking for the conversion of various crudes into gasoline show that hydrogenation is definitely justified if gasoline prices are above a certain minimum (7.9 cents per gallon in 1933) and if there is a spread between the price of crude and that of fuel oil exceeding a comparatively small minimum value (22-50 cents per barrel in 1934). While the numerical values reported by these authors no longer apply today, the trend is unchanged.

Conclusion

Destructive (or perhaps more adequately "creative") hydrogenation has during the past year recaptured some of its earlier interest to American oil men from which it had been largely displaced by the general preoccupation with the Fischer-Tropsch process as a source of synthetic fuels. In a properly balanced economy, the two processes must be looked upon as complementary rather than competitive.

TABLE 4

Operation	Investment Cost
Coal and Paste Preparation	$ 5,223,000
Hydrogenation Proper	30,110,000
Gas Supply	16,906,000
Utilities and Storage	12,154,000

TABLE 5

Cost of Coal per Ton	Cost of Fuel Oil, per MM Btu
$3.00	$0.770
4.00	.845
5.00	.921

TABLE 6

Operation	Investment Cost
Hydrogen Production and Compression	$61,000,000
Hydrogenation, Including Coal Preparation	80,000,000
Distillation, Tankage and Phenols Recovery	16,000,000
Power, Utilities and General Plant Facilities	87,000,000
Total	$244,000,000

Perhaps the main field in which actual competition between high-pressure hydrogenation and Fischer-Tropsch is encountered is in the production of motor fuel from coal. As long as natural gas serves as a basis for synthesis, hydrogenation must take the back seat for this particular field of operations. However, even in this field, a proper choice of process may go a long way toward stretching and more fully utilizing extant supplies of crude. Gasoline yields from petroleum sources may be increased by as much as 25-35 percent by combining hydrogenation with cracking processes.

As a source of aviation gasoline, hydrogenation probably has a certain advantage over all versions of the Fischer-Tropsch process which have been reported to date. The high-pressure process permits not only the production of gasolines of high octane number on a wholly synthetic basis, but also yields products of special properties, such as high-flash ("safety") gasolines, if so desired.

As a source of middle oils and heavy oils synthesized from coal, high-pressure hydrogenation shows a distinct economic advantage over Fischer-Tropsch operation. The conversion can be carried out in a single high-pressure stage and hydrogen consumption is comparatively low. Here, then, is an important potential source for the large-scale production of heavy fuel oils and middle oils for jet engines.

At the same time, hydrogenation processes are an immensely rich source of tar acids which may be recovered from intermediate products of the process by known processes of the coal tar industry.

Low-grade, high-sulfur and high-asphalt petroleum crudes may be readily and economically upgraded by hydrogenation. Poor stocks may be converted to high-quality lube oils and diesel fuels.

The very versatility of high-pressure hydrogenation permits its incorporation into a large number of refinery processes and even its combination with the Fischer-Tropsch process to accomplish aims which can otherwise be achieved only at an economic disadvantage.

Already a highly developed process, high-pressure hydrogenation still leaves room for much research and improvement. Realization of the potentialities of the process will well repay efforts in this direction.

End of Series

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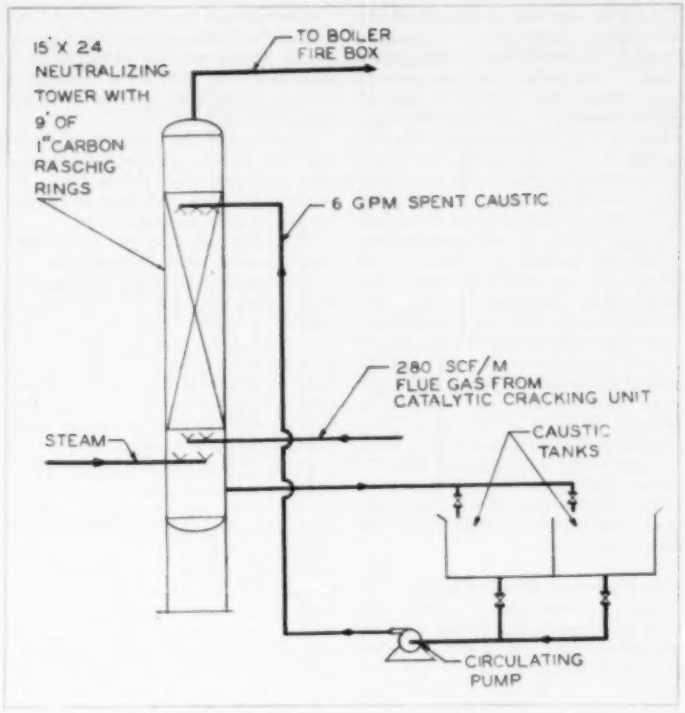

Figure 1. Pilot Unit, Caustic Neutralizing at Aurora Gasoline Company, Detroit.

Solved---
Difficult WASTE DISPOSAL Problem

Flue gases from catalyst regeneration serve for the neutralization of spent caustic

KENNETH M. BROWN and SOMA KURTIS

THE CAUSTIC solutions used for chemical treatment of petroleum products are the most obnoxious types of waste material with which a refiner has to contend. The use of carbon dioxide for neutralizing caustic is a well known reaction, but one which presents several problems in practical application. Now, commercial operation has been achieved in at least three plants, with the catalyst regeneration system of a catalytic cracking unit serving as the source of flue gas under pressure. Compression of flue gas in mechanical equipment, a difficult matter because of corrosion problems, is thus avoided. Difficulties encountered in the operation of the caustic neutralization method are noted and the solutions worked out discussed. The original presentation was before the Western Petroleum Refiners Association at Wichita, Kan., in June. Mr. Brown is with Universal Oil Products Company, and Mr. Kurtis with Aurora Gasoline Company.

WASTE disposal experts say that waste material being discharged into surface water should not be toxic to aquatic life, that it should have no chemical oxygen demand, that it should not change the pH of the surface water into which it flows, that it should not impart a bad taste or a disagreeable odor and that it should not increase the total solids content of the water into which it flows beyond a certain maximum. The waste material should not cause the surface water to become unsightly or discolored or make it turbid. All of these items taken collectively mean that the waste should not change the environment or the nature of the water enough to affect seriously the aquatic life or to make its treatment for subsequent use by others excessively expensive.

Spent caustic soda from petroleum refining contains almost all of the things that a suitable waste should not. Certain phenolic compounds are reported by some authorities to be toxic to fresh water fish in concentrations of one to ten parts per million.[1] Almost all spent caustic contains phenols, often referred to as acid oils, particularly those caustic solutions that have been used to treat either thermally cracked or catalytically cracked gasoline. Almost all spent caustic contains sulfide which ionizes to hydrogen sulfide. Hydrogen sulfide is toxic to fish in concentrations as low as 0.9 to 6.5 ppm.[1] Certain chemicals will oxidize under mild conditions, robbing aquatic life of necessary oxygen. Sulfides, sulfites and thiosulfites have an oxygen demand as shown by the following chemical equations:

Chemical Oxygen Demand of Some Sulfur Compounds

$$Na_2S + \tfrac{1}{2}\,O_2 + H_2O \rightarrow 2\,NaOH + S \quad (1)$$

$$2\,Na_2S + 3\,O_2 \rightarrow 2\,Na_2S_2O_3 \quad (2)$$

$$Na_2S_2O_3 + \tfrac{1}{2}\,O_2 \rightarrow Na_2SO_4 + S \quad (3)$$

$$Na_2SO_3 + \tfrac{1}{2}\,O_2 \rightarrow Na_2SO_4 \quad (4)$$

It is only when the sulfur has been oxidized to the sulfate that it no longer has an oxygen demand.

A change in pH is a shock to aquatic life. Caustic solutions are reduced in pH by dilution as can be seen in Table 1.

It can be seen from Table 1 that a caustic waste having a pH of 14 and a concentration of say 7.5% NaOH (10°Be'.) must be diluted to 20,000 times its original volume to get to 10 pH which is necessary to avoid damaging the more tolerant forms of aquatic life. To get the pH below 8,

TABLE 1
pH of NaOH and HCl Solutions

°Bé.	Percent NaOH or Percent HCl	Normality	pH
11	20	20	14
16	30	10	14
22	17	5	14
9	7.5	2	14
2.8	3.8	1	13.1
0.5	0.4	0.1	13.0
0	0.04	0.01	12.0
0	0.0004	0.0001	10
0	0.000004	0.000001	8
0	0	0	7
	0.000004	0.000001	6
0	0.00036	0.0001	4
	0.036	0.01	2
	0.36	0.1	1.02
	3.6	1.0	0.0

the range in which most aquatic life will continue to habitate the water, it must be diluted to 2 million times its original volume. Thus it is seen that a relatively large stream is necessary to reduce the alkalinity of caustic waste.

Waste caustic contains many compounds such as mercaptans, sulfides, thiophenols, phenols and others which will impart an undesirable taste and odor when discharged to surface water. If the surface water is subsequently treated with chlorine to render it fit for drinking the phenol content is extremely important. It must be less than a few parts per billion in order to avoid a medicinal iodoform taste.

Dissolved solids are objectionable above a certain maximum concentration. According to Hart this upper limit of toleration for fish is about 350 ppm.[1] Also, high concentrations of solids can render water unfit for future use. Hart[2] reports that surface waters contain about 70 to 400 ppm. of total dissolved solids and in 50 percent of the water it is less than 170 ppm. Waste containing 10 percent total solids must be diluted to 1000 times its original volume to get it below 100 ppm.

Certain phenolic compounds present in refinery spent caustic act as dyes or indicators at the proper pH and may cause serious problems when the caustic is dumped into surface waters. Spent caustic can also cause the water to become turbid through the introduction of sulfates which combine with calcium and magnesium in the surface water to form insoluble sulfates, and it can also cause precipitation of carbonate through the familiar water softening reaction which involves the formation of calcium and magnesium carbonate from their respective bicarbonates. Also, free sulfur may be liberated as shown in equation 1 and 3 above.

$$NaOH + Ca(HCO_3)_2 \rightarrow NaCO_3 + CaCO_3 + H_2O.$$

Turbidity is objectionable since it reduces the amount of light penetration which is necessary for plant life. Thus it is seen that almost all of the materials in spent caustic are objectionable when discharged into surface water. If the body of surface water is large enough, the discharged material will eventually be diluted to the point where it is not objectionable. Also the so-called "self purification" of water will eventually render the waste material unobjectionable provided the waste does not kill the microorganisms that are active in self purification. Where the amount of waste is large relative to the body of water into which it is discharged, it can cause serious damage. The use to which surface water is to be put and the amount of self purification it will undergo should determine the amount of treatment given to industrial waste water effluent. Such a policy has been adopted in the Administration of Public Law 845, according to Carl E. Schwob before the May, 1950 meeting of the API Refining Division in Cleveland. Not all local authorities take such a logical stand.

Types of Waste Caustic

Not all waste caustic contains the same components and the use to which the caustic has been put will determine to a large degree the type of treatment that is best to render the waste caustic fit for disposal. Caustic used for treating light fractions such as LPG or natural gasoline or light straight run gasoline will contain only sulfides and mercaptides, principally sulfides, and, of course, a certain amount of free alkali.

Caustic used for the treatment of thermally cracked gasoline may contain sulfides, mercaptides, phenolates, thiophenolates and salts of naphthenic and aliphatic acids. All of these materials, with the possible exception of the salts of aliphatic and naphthenic acids, are objectionable.

TABLE 2
Comparison of Strength of Acids and Bases

ACIDS	Ionization Constant	pH of 0.1 Molar Solution
HCl	10^{7}	1.0
Acetic Acid	1.8×10^{-5}	2.9
Propionic	1.3×10^{-5}	
Butyric	1.5×10^{-5}	
Typical Naphthenic Acid*	1.2×10^{-5}	2.60
Carbonic Acid	3.4×10^{-7}	3.7
Hydrogen Sulfide	3.3×10^{-7}	3.7
Thiophenol	1.5×10^{-7}	3.9
Thiocresol mixture	1.0×10^{-6}	
Phenol	1.1×10^{-10}	5.0
Ethyl Mercaptan	2.3×10^{-11}	5.8
Propyl Mercaptan	1.5×10^{-11}	
Water	0.6×10^{-14}	7.0
Bases:		
Ammonium Hydroxide	1.75×10^{-5}	11.1
Sodium Hydroxide	10^{0}	13.0

* Pentamethylene carboxylic acid.

Caustic used for treatment of catalytically cracked gasoline will be composed almost entirely of phenolates, thiophenolates and some mercaptan sulfur. There may also be a small amount of sulfide.

Caustic used for treatment of kerosine may contain sulfide and mercaptide and may also contain salts of naphthenic acids. This type of caustic usually is high in neutral oils.

The materials removed by caustic are known as weak organic acids. It is a well-known principle in chemistry that a stronger acid will displace or liberate a weaker acid from its salt. For example: hydrochloric acid will liberate acetic acid from sodium acetate; acetic acid will liberate hydrogen sulfide from sodium sulfide; hydrogen sulfide will liberate mercaptan from sodium mercaptide, etc.

Table 2 lists various organic acids that are found in petroleum products in the order of decreasing acidity. Hydrogen chloride is included, not because it is ordinarily found in refined petroleum products or in spent caustic, but merely to show the relative strength. Also, certain basic compounds are included for comparison. The strength of the acid is shown by the ionization constant. The smaller the exponent, the weaker the acid. Another and probably more familiar method of expressing acid strength is shown by pH which is also included in the table. It will be noted that carbonic acid has the same strength as hydrogen sulfide and that carbonic acid is a stronger acid than the phenols and mercaptans. Acetic acid and naphthenic acid are stronger than carbonic acid. This means that acetic acid will liberate carbon dioxide, hydrogen sulfide, phenol, etc. Carbonic acid, which is the acid formed when carbon dioxide dissolves in water, will liberate phenol, mercaptans, etc.

Although carbon dioxide is of the same strength as hydrogen sulfide, it will liberate hydrogen sulfide when present in a large excess provided that the liberated hydrogen sulfide is carried away from the solution. Table 3 shows the pH of some sodium salts of the various acids shown in Table 2. A mixture of caustic with these various sodium salts, which is the condition in the spent caustic solution, will usually have the pH of the free alkali since this is a much stronger base than the sodium salt of the alkali and a weak acid. Thiophenol can be liberated by carbon dioxide if the liberated material can be removed by stripping vapors.

While the use of carbon dioxide for neutralizing caustic is a well known chemical reaction in a qualitative way, putting such a neutralizing process

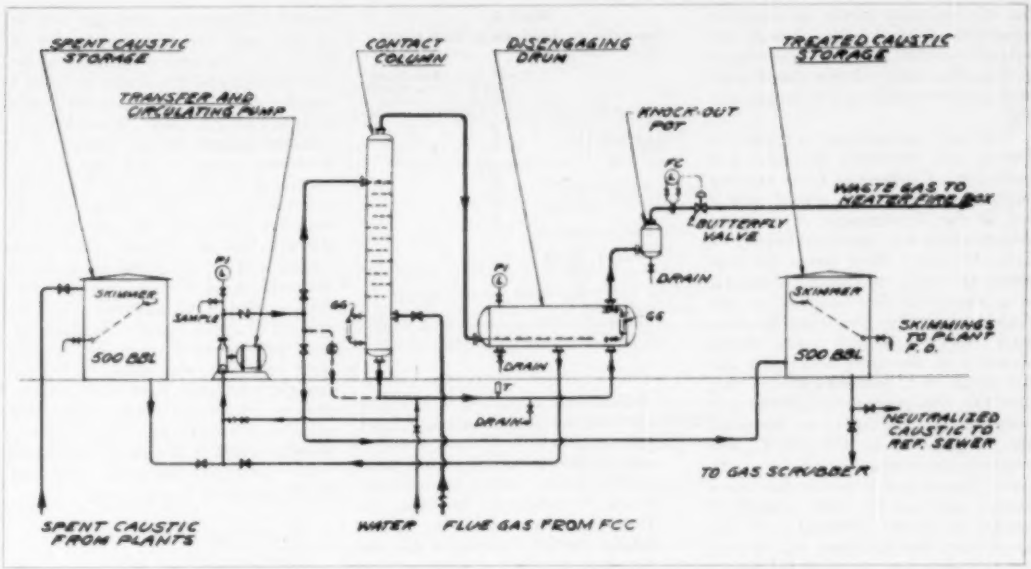

Figure 2. Spent Caustic Neutralizing Unit, Aurora Gasoline Company, Detroit.

into actual operation, using flue gas as a source of carbon dioxide, presents several problems.

In the first place the flue gas is usually available at atmospheric pressure and in order to be used must have the pressure raised by a blower or compressor. Flue gas is not corrosive as long as it is hot. Almost all fuels burned contain sulfur, and therefore all flue gases contain sulfur dioxide. When the flue gas is cooled below its dew point, water condenses and this water then dissolves the sulfur dioxide forming sulfurous acid which is one of the most corrosive acids known. The use of a compressor then is almost eliminated since the compressor must be run on cool flue gas, and it would require expensive acid resistant equipment to cool the flue gas and remove the sulfur dioxide. Fans can be used on hot flue gas but the pressure output is limited to 10-14 inches of water. The use of flue gas from a stack is not advantageous because of these limitations, and flue gas has not been used widely by the refining industry for neutralizing caustic. As the need for caustic disposal became more critical, refiners became more willing to install expensive equipment if they could have some assurance of beneficial results. Fortunately for many, the advent of catalytic cracking in its improved post-war design, makes flue gas available at 15-20 pounds pressure, thus overcoming one of the most difficult obstacles in the use of flue gas for caustic neutralization. It was natural, therefore, that Aurora Gasoline Company, having the first postwar catalytic cracking unit, would be the first to make a trial with flue gas when their caustic disposal problem reached a climax.

The original Aurora Gasoline Company pilot unit design is shown in Figure 1. It involved passing hot flue gas from the downstream side of the catalytic cracking unit waste heat boiler upward through a vertical tower which contained carbon Raschig ring packing. The flue gas leaving the top of the tower passed directly into a boiler fire box. Spent caustic collected in one of the caustic tanks was circulated over the top of a vertical Raschig ring packed tower coming in contact with the rising flue gas as it flowed down over the rings. Steam injection was provided to prevent excessive evaporation in order to avoid dehydration, and to prevent the caustic concentration from getting into the range where caustic embrittlement would become a problem. The efficiency of carbon dioxide utilization, assumed to be 25 percent for design purposes, turned out to be about 50 percent for the few analyses made.

Table 4 gives the composition of a sample before and after neutralization in the pilot unit. Experience in the early unit showed that the liberated phenols did not form a separate acid oil layer, undoubtedly due to the fact that they were distilled from the solution almost as rapidly as they were liberated. The temperature in the neutralization system was considerably below the boiling point of the phenols

TABLE 3

Acidity of Sodium Salts of Certain Acids Occurring in Unfinished Petroleum Products

COMPOUND	pH of 0.1 M Solution
Sodium Chloride	7
Sodium Sulfate	7
Sodium Acetate	8.9
Sodium Naphthenate	9.0
Sodium Bicarbonate	8.5
Sodium Carbonate	11.5
Sodium Sulfide	13.0
Sodium Bisulfide	10.7
Sodium Thiophenylate	9.9
Sodium Phenolate	11.0
Sodium Ethyl Mercaptide	11.8

TABLE 4

Spent Caustic Neutralization Aurora Pilot Unit

	SPENT CAUSTIC	
	Before Neutralization	After Neutralization
Appearance:		
Before Filtration	Copious Black ppt.	Copious Black ppt.
After Filtration	Yellow Strong H_2S Odor	Yellow Clear Good Odor
Total Alkalinity (M.O. End Point) Calculated as NaOH, Percent	10.9	7.70
Sodium Mercaptide, Calculated as NaOH, Percent	0.32	nil
Sodium Sulfide, Calculated as NaOH, Percent	8.6	nil
Sodium Hydrogen Sulfide, Calculated as NaOH, Percent	2.0	
Sodium Carbonate and Bicarbonate, Calculated as NaOH, Percent		7.70
Phenols, Percent (Approx.)	0.2	0.2

but the stripping action of excessive quantities of gas passing through the solution carried out the phenols as well as the more volatile constituents such as mercaptans and hydrogen sulfide.

This early neutralization system at Detroit was hurriedly designed and built almost overnight from existing equipment. Experience gained with it led to the development of a better system which was described briefly by J. C. Albright.[2] More recent developments are worth mentioning. Figure 2 is a simplified flow diagram of the Aurora unit. Flue gas from the catalytic cracking unit is taken downstream from the waste heat boiler and has about 10-12 percent CO_2, 5-6 percent CO, 1½ percent O_2 and the balance nitrogen and inerts. At this point the temperature is 450-500° F. The neutralizing system includes two 500-barrel tanks—one to accumulate spent caustic and one to hold neutralized caustic to permit liberated acid oils to separate for skimming and to permit the laboratory to check before authorizing disposal to the sewer.

Flue Gas Contact

An all iron centrifugal pump charges a batch of spent caustic over the top of a vertical contact tower which is fitted with ten perforated side-to-side pans. Flue gas introduced at the bottom rises through this tower, coming into intimate contact with the down-flowing liquid. A batch of spent caustic, after dilution to 10-12°Be', amounts to about 1700-2000 gallons, and is charged at a rate of about 10 gallons per minute. About 80 percent of the sulfide is eliminated while a batch is being charged.

The flue gas leaving the top of the tower enters a horizontal disengaging drum through an internal perforated distributor which provides additional contacting. The liquid from the bottom of the tower also flows into this drum. After a batch is charged the charge pump suction is switched to circulate the liquor from the disengaging drum back over the tower until neutralization is complete; upon which the liquor is pumped to the 500-barrel treated storage tank.

The flue gas passes from the disengaging drum through a butterfly control valve to the fire box of a process heater where the hydrogen sulfide, mercaptans, phenols and other objectionable components are burned.

Certain operational difficulties have been encountered. These can be divided into three classes: 1) foaming, 2) acid oils, and 3) solids.

1) *Foaming:* Spent caustic from the kerosine doctor sweetening unit contains salts of naphthenic acids. When this caustic was included in the neutralizer charge, severe foaming resulted. Anti-foaming agents such as iso-amyl and octyl alcohol were useful in reducing foam formation; however, the Dow-Corning anti-foam agent known as "DC Anti-foam A" was found to be very effective at concentrations in the range of 50 parts per million. This particular caustic does not contain sulfide and is no longer a part of the charge to the neutralizer.

2) *Acid Oils:* When caustic solutions from cracked gasoline containing about 40 percent acid oils are neutralized without dilution with other alkaline wastes, the acid oils accumulate in a separate phase. If sufficiently diluted the acid oils are stripped out by the flue gas.

3) *Solids:* It is necessary to keep the gravity of the charge below about 10-12°Be'. Otherwise crystals of carbonate and bicarbonate will form and cause difficulty due to plugged lines.

The inlet line is insulated to keep the flue gas above its dew point and no corrosion difficulties have been encountered after nine months of service with steel equipment.

TABLE 5
Spent Caustic Available at Rock Island

	From Catalytic Gasoline Treating	From Straight Run Gasoline Treating
Gravity, °Be	28	10-12
Total Alkalinity, Percent NaOH	17.6	6-8
Percent Spent*	9.8	>80
pH	10.6	
Acid Oil by Liberation with Acid, Vol. Percent	30	
Phenols (by Ultraviolet) Percent	24	
Thiophenols (by Ultraviolet) Percent	1.3	
Na_2S, Calc. as NaOH, Percent	1.3	

* Percent Spent = $\frac{\text{cc Acid to M.O. End Point} - \text{cc Acid to P.P. End Point}}{\text{cc Acid to M.O. End Point}}$

Lab and Field Tests

Neutralization is considered complete when the sulfide ion reaches 0.2 percent or less by potentiometric titration with silver nitrate. At this point the hot carbonated solution is free of odor. A laboratory test is made for phenols. The field test consists of a check for sulfide with lead acetate paper. Three to four 1700-gallon batches can be neutralized per day.

In addition to the unit at Aurora, two more units have recently been installed by Rock Island Refining Company and Globe Oil and Refining Company. The Rock Island unit was placed in operation in the middle of May this year and the Globe unit more recently. These new units are similar to the unit shown schematically in Figure 3. Experience gained on the Aurora unit and the desire to build a simpler, less expensive unit led to this design. Flue gas passes through a distributor located in the bottom of a horizontal vessel coming into intimate contact as it passes through the caustic solution in the vessel. From the neutralizing vessel the flue gas flows to the fire box of a heater. The Rock Island unit is composed of a 4-foot diameter vessel 17 feet long and will take a charge of approximately 30 barrels of spent caustic. At Rock Island three types of spent caustic solutions have been neutralized. A typical analysis of two of these caustic materials is included in Table 5. The third solution is a 50-50 mixture of the two listed in Table 5. The Rock Island unit is not equipped with a flow meter and the flue gas rate is not known.

Evaporation of Acid Oils

When caustic from treatment of catalystic gasoline is charged, neutralization and complete evaporation of acid oils requires about 72 hours. The bulk of the time is used in evaporating the acid oils. A slightly different design than that shown is desirable when the spent caustic contains a high concentration of acid oils. Perhaps a design such as the Aurora unit, is more desirable since the acid oil layer can be withdrawn from the system with greater facility. The sulfide content is completely eliminated in about 24 hours.

The second type of caustic is caustic resulting from the treatment of straight-run gasoline and is composed principally of sodium hydrogen sulfide and sodium sulfide. It takes approximately 24 hours to neutralize a batch of this material since there is no acid oil to evaporate. A 50-50 mixture of caustic from the catalytic gasoline treaters and from the straight-run gasoline treater requires about 36 hours for neutralization and evaporation of acid oils—about half the time required when the straight catalytic gasoline caustic is charged. The reduced time probably results from the fact that sodium hydrogen sulfide will liberate acid oils and that evaporation of acid oils can take place from the beginning of the run, whereas it takes some time before there is sufficient carbon dioxide absorbed to liberate acid oil.

Operators of catalytic cracking units have a means of disposing of spent caustic solution. For those refiners who do not have catalytic cracking units, a fan might be used to transport the flue gas through a

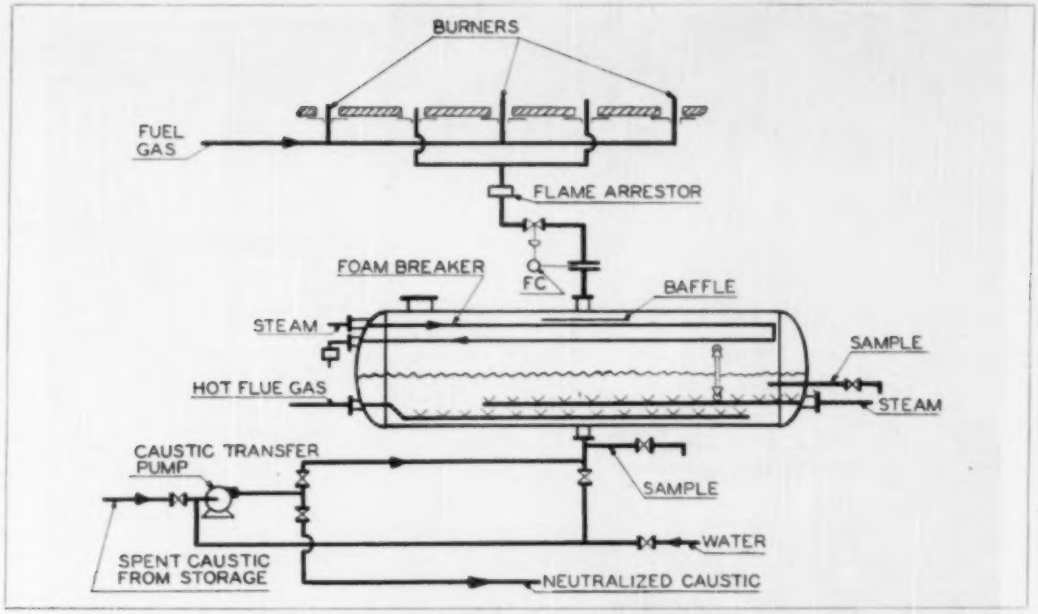

Figure 3. Caustic Neutralizer Using Flue Gas from Catalytic Cracking Unit.

neutralizing system. Induced draft fans capable of handling hot flue gas are available. Such fans can put up sufficient pressure to get the flue gas through a neutralizer of the type shown in Figure 3, and into the furnace setting. But large cross section duct work would be necessary to keep line pressure drop reasonably low. Another means that might be employed at greater expense for equipment to utilize stack gas might be the scheme proposed by E. P. Kropp at the Cleveland meeting of the API. This equipment involved passing flue gas through two large vertical chambers connected in series. These vertical chambers were equipped with sprays for atomizing the fluid so as to get contact with the gas passing through the vessels. In adapting this for neutralizing caustic, the sprays would have to be made of a material resistant to corrosion by hot caustic.

Summarizing, there are three caustic neutralizers in use employing flue gas from a catalytic cracking unit. These neutralizers produce a finished caustic which can be discharged in the one case through a city sewer system and into the Detroit River, and in another case into a small stream that has as its principal source the waste water from a medium sized refinery. It appears to be perfectly feasible to use a fan of the induced draft type to blow hot flue gas through a caustic neutralizer. The time involved for neutralization, when a blower is used to transport the flue gas, may be longer due to the fact that the pressure on the system will be considerably lower and the rate of absorption of the carbon dioxide will be lower.

A neutralizer that must handle a spent caustic solution containing a large quantity of acid oils should be equipped with some means of skimming the liberated acid oils so that excessive evaporation times need not be used. Excessive evaporation times offer no objection if the neutralizing vessel can handle batches of caustic large enough to keep ahead of the accumulation of spent caustic.

ACKNOWLEDGEMENT

The assistance of various associates of Universal Oil Products Company, Mr. C. O. Anderson of the Rock Island Refining Co. and Mr. J. M. Lawson of the Globe Oil & Refining Co. is gratefully acknowledged.

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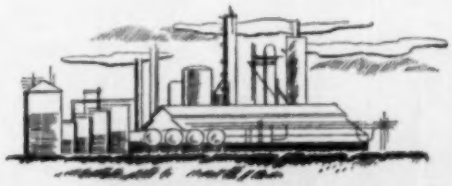


Main Fractionating Column of Standard Oil Company of California's Bakersfield Refinery's Crude Unit Framed by Working Tanks.

Bakersfield Refinery Modernized and Expanded

THE Bakersfield refinery of the Standard Oil Company of California, originally built in 1912, has undergone an extensive modernization program designed to improve product quality, and to increase by 50 percent the amount of crude oil which can be processed daily. About 18 months was required to complete the added facilities.

The new crude unit started up in August, 1949, and "has operated satisfactorily since that time, indications being that its first run will last more than a year," officials declared. Products have been gasoline, diesel, stove oil, furnace oil, and fuel oil or cracking unit feed.

Crudes run have been such typical San Joaquin Valley crudes as Midway Light and Greeley with a gravity range of 27° to 36° API. Feed rate has been at approximately design conditions.

Operation of the new cracking unit was started in January and has given excellent service, according to officials. The first run was 100 days, and the unit operated at capacity throughout this period. Feed stocks have consisted of residuum from Midway Light and Greeley, supplemented with some heavy San Joaquin Valley crudes. The first shutdown was completed on schedule and the unit is back on stream.

The Unisol Plant came on stream at the same time as the cracker and has handled the treating problem without difficulty.

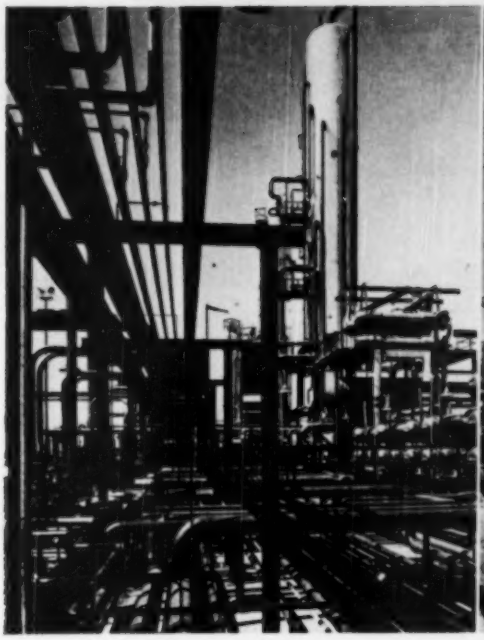
The whole cracked gasoline is Unisol treated and is then separated into two cuts. The heavy cut is acid treated and rerun.

Operation of the new boiler plant and other auxiliaries has been entirely satisfactory.

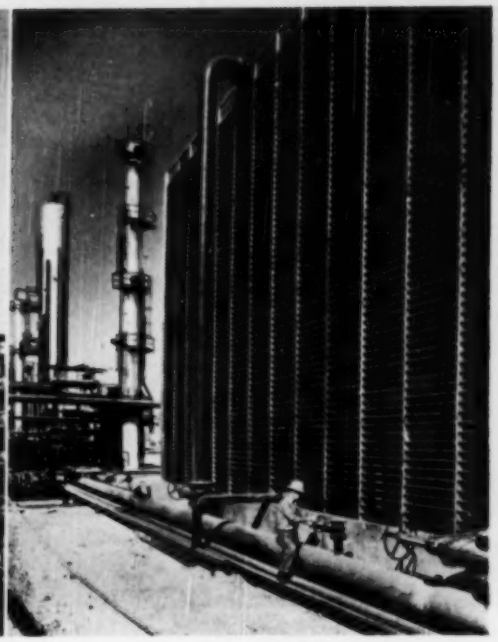
The new facilities raised the crude oil processing capacity to 20,000 barrels daily. These new facilities were designed to produce a daily average of 8000 barrels gasoline, 2200 barrels stove oil, 1900 barrels diesel fuel and 6000 barrels fuel oil. Reservoir and tank capacity now total more than 3 million barrels and boilers are capable of generating 120,000 barrels of steam each hour.

Note further photos on opposite page.

Control Room of New Crude Unit at Standard of California's Bakersfield Refinery.

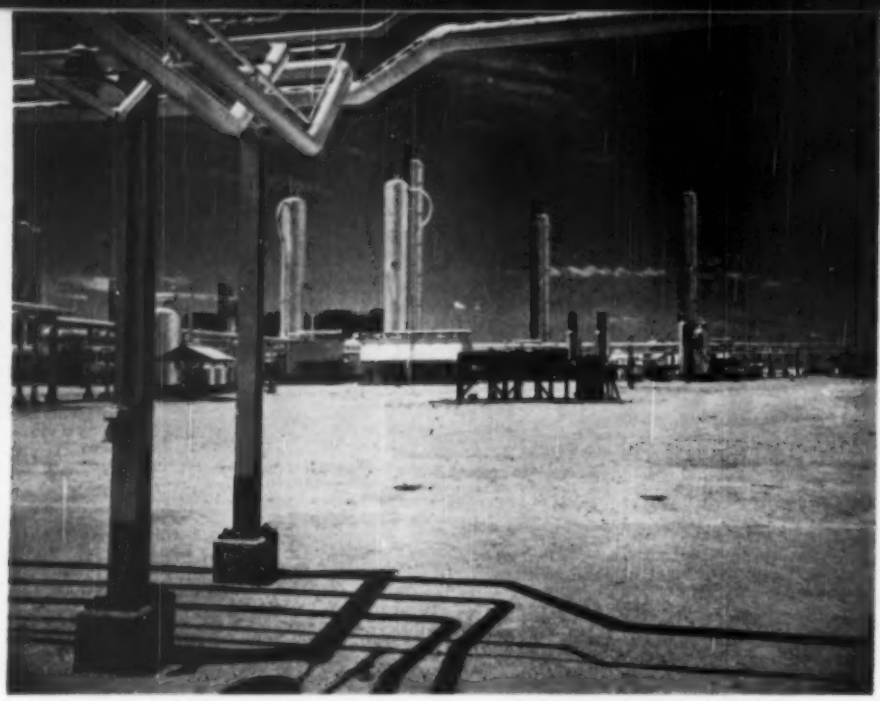


Pattern of Pipes and Heat Exchangers below Main Fractionating Column at Bakersfield.



Water Cooler and Part of New Crude Unit, Standard of California's Bakersfield Plant.

Aerial View, Bakersfield Refinery, Bakersfield, Calif., a Standard Oil Company of California property.



Distillation and fractionation area of the new North Cowden gasoline plant operated by Stanolind Oil and Gas Company for 21 owners. Five columns near center are the primary and secondary stills, deethanizer, depropanizer, and debutanizer. Air cooling units in the center foreground provide cooling of overhead vapors from the two stills.

SOUR GAS—

New Plant Operating MEA, Dehydration, Caustic, and Copper Chloride Units

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Stanolind Oil and Gas Company, Tulsa

THE North Cowden field is located about 25 miles west of Midland, Texas. The field was discovered in October of 1930, but active development was not commenced until 1934. By 1941, development of the field was essentially completed. The field covers some 27,000 acres on which 680 producing wells have been drilled on 40-acre proration units. Approximately 7900 acres were initially underlain by a gas-cap. Accumulative oil production at the end of 1949 approximated 79,000,000 barrels. The oil is termed "West Texas sour," having approximately 1.78 percent sulfur by weight and an average 32° API gravity at 60° F. Original reservoir pressure was approximately 1800 psi. Pressure has declined continuously and had reached a value of 727 psi. by December, 1949.

The cooperative gas injection program has been carried out by dividing the field into injection blocks of approximately 640 acres each. This was done to expedite the gas injection program, since lengthy negotiations would have been required to form a fieldwide unit. To date, 33 such injection blocks have been formed, comprising some 20,500 acres. The project is starting out with one injection well in each block although a minimum of two such wells per block is the goal. Thirty-two oil operators (owners of 80 percent of the developed acreage) have joined in the program. The opportunity to enter the program is still open to all royalty and working interest owners in the field.

Present plant capacity is 50,000 mcf. daily, but the plant is designed for ultimate enlargement to 100,000 mcf. daily by adding compressors, heat exchange equipment and utility features, and by paralleling certain process services.

PLANNING a process unit is usually a complex undertaking at best; however, in some cases where such conditions are present, as in the plant described here, the problem covers an especially great range. In the North Cowden plant, it was decided that 10-psig. field gases should be processed to remove liquid products and the residue gas injected into the crude oil formation as a repressuring measure. The process scheme selected, for instance, could have used absorption pressures at low, medium, or very high levels. The gas purification operation, on 50 million cubic feet daily of sour gas, could have been conducted at several points in the process. There was not a pipe line inlet pressure requirement to influence processing pressures. The engineers who planned the plant thus had perhaps more than the usual freedom of choice in setting up the process scheme. The principal influence was their own judgment of how their selection of the many operating variables would affect the initial plant cost, operating costs, and long term realization from the installation.

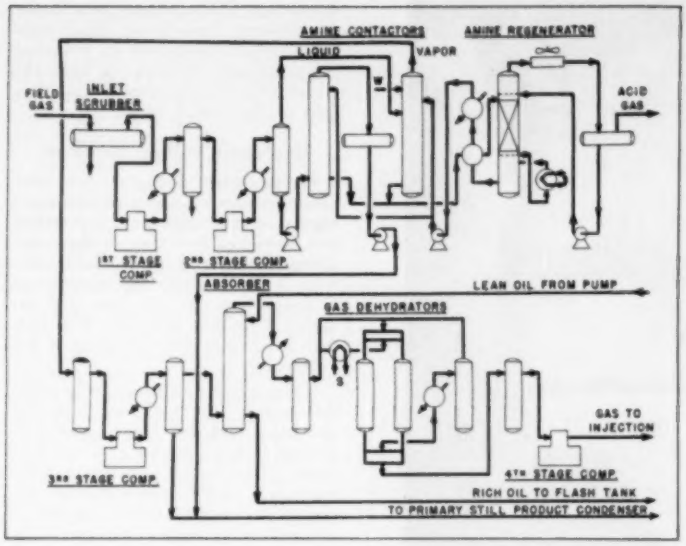


Figure 1. Compression, Sweetening, Absorption and Dehydration, North Cowden Gasoline Plant.

The plant is designed for 60 percent propane recovery and essentially 100 percent recovery of butanes and heavier. Liquid products, when processing 50,000 mcf. daily of gas of the design composition shown, are expected to total 150,000 gallons per day.

Process features include monoethanolamine sweetening of gas and condensate after the second stage of compression, oil absorption at 700 psig., solid desiccant dehydration of residue gas and compression of residue gas to 1700 psig. for injection. The absorption-distillation cycle includes a reabsorber for recycle vapor and a two still distillation section. The three-column fractionation system is cascade. Product treating facilities include a regenerative caustic unit which removes mercaptans from depropanizer bottoms, a batch caustic wash, followed by dehydrators, for propane and solid copper chloride treaters for gasoline.

The plant was designed and constructed by Stearns-Roger Manufacturing Company in conjunction with Stanolind Oil and Gas Company and other plant owners. Stanolind operates the plant for a group of 21 owners. This same group also owns the older gasoline plant in the field which was purchased from Cities Service Oil Company to handle the gas volumes in excess of 100,000 mcf. daily and which is presently being held in standby condition.

Compression

Field gas is gathered from 171 batteries at a maximum gathering system pressure of 10 psig. Gas enters the plant through four meter runs and passes into a large horizontal scrubber designed to catch solid particles or crude oil that may enter through the field lines. Pressure in the scrubber is maintained at approximately 2 psig. by compressor speed control.

The compressor installation consists of ten 1600-h.p. units installed in two separate compressor houses. The five compressors in one building are equipped with three stages and discharge at 717 psig. The five compressors in the second building are equipped with four stages, the first three stages paralleling the corre-

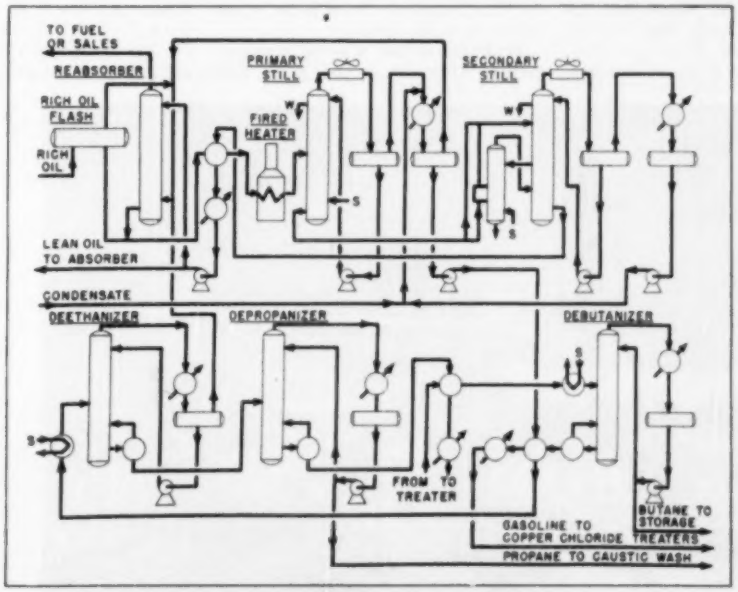


Figure 2. Distillation and Fractionation Flow Chart of North Cowden Gasoline Plant.

Rich oil heater and boilers from the process area. One of the process pumps is at the left. Capacity of each boiler is 42,500 pounds per hour of steam at 300 psi. The heater has a capacity of 36,000,000 Btu. per hour.

sponding stages of the three stage machines, and the fourth stage serving to compress residue gas to 1700 psig. for injection. Each group of compressors has a separate closed jacket water system with air cooling.

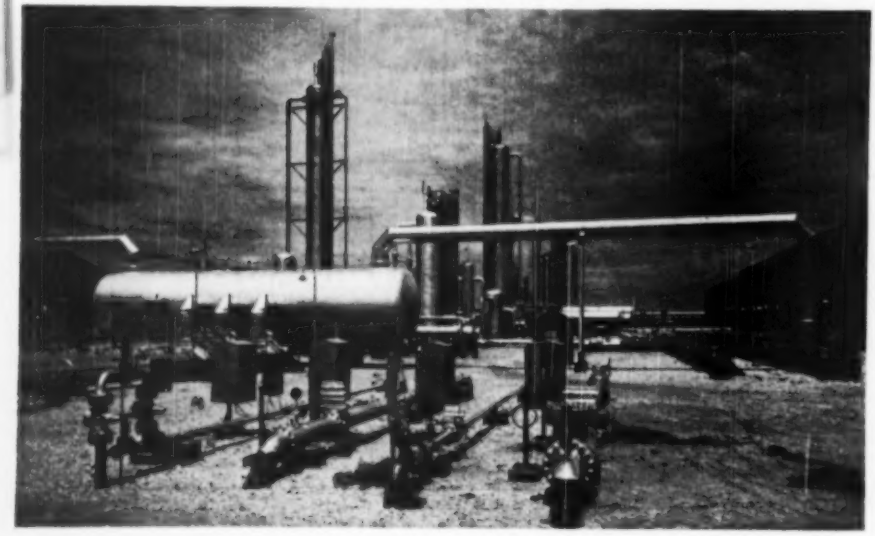
Hydrogen sulfide removal is accomplished after the second stage, and third stage discharge gas goes to the oil absorber. Second and third stage compression condensate is collected for processing. Residue gas from the oil absorber is dehydrated and then goes to the fourth stage.

Hydrogen Sulfide Removal

Second stage discharge gas after cooling passes through a scrubber for separation of condensed hydrocarbons and water and then goes to the vapor amine contactor. Lean monoethanolamine is pumped over the contactor at a design rate of 234 gpm. and removes hydrogen sulfide to less than 0.25 grains per 100 cubic feet in the overhead.

Hydrocarbon condensate collected in the scrubber is pumped through the liquid amine contactor counter-current to a small stream (about 4 gpm.) of lean amine. The sweet condensate flows through a settler which catches entrained droplets of amine and then is pumped to the fractionator feed tank.

Rich amine from the bottom of both contactors joins and is heated by exchange with hot lean amine before entering the top of the regenerator. As the rich amine flows down through the tower, hydrogen sulfide and carbon dioxide are stripped from it by steam rising from the reboiler. Design steam rate to the reboiler is 17,600 pounds per hour. Lean amine flows from the bottom of the tower through the exchanger and cooler to the circulating pump suction where it is picked up and pumped back to the contactors. Regenerator overhead is air cooled to about 160° F., to condense most of the steam, and then enters the reflux accumulator. Condensed steam is



Inlet gas lines and horizontal inlet gas scrubber of the North Cowden gasoline plant operated by Stanolind Oil and Gas Company for 21 owners. Vessels in the background are the amine contactor and regenerator and the main absorber. The ten 1600-hp. compressors are installed in two separate compressor buildings — five to a building.

pumped from the accumulator back to the regenerator as reflux and the acid gas is flared. Water to make up that lost with the acid gas is pumped onto the water wash tray in the vapor contactor and serves to minimize amine loss in the overhead gas.

Auxiliary equipment to the amine unit includes a filter which removes suspended material, particularly iron sulfide, and a redistillation unit or amine reclaimer.

Residue Gas System

Residue gas from the main absorber is cooled and then, after plant fuel is removed, flows to a solid desiccant dehydration unit. Two dehydrator towers are used, one being on stream while the other is being regenerated and cooled. The cycle is designed on a basis of 12 hours dehydration and 12 hours regeneration with downflow during dehydration, upflow during heating, and downflow during cooling. Regeneration gas rate is about 400 mcf. per hour.

Dehydrated gas passes through a special scrubber equipped to contact the gas with oil to remove particles of desiccant and thereby protect the fourth stage compressor cylinders. Fourth stage discharge gas goes directly to the injection system without cooling.

Dehydrated residue gas is also furnished to the leases for fuel. Provisions have been made to sell residue gas not required for injection or for plant and lease fuel.

TABLE 1
Design Gas Composition

Component	Mol Percent
Nitrogen	2.55
Hydrogen Sulfide	1.00
Carbon Dioxide	1.48
Methane	74.65
Ethane	9.62
Propane	4.30
Butanes	3.22
Pentanes	1.50
Hexanes	1.01
Heptanes and heavier	0.58
	100.00

Daily Production at 50,000 Mcf

Product	Gallons
Propane	35,000
Butanes	22,700
Natural Gasoline (28-pounds Rvp.)	62,730

Absorption and Distillation

Primary absorption is carried out at 700 psig. with a design lean oil rate of 461 gpm. Rich oil from the bottom of the absorber is flashed at 287 psig. in the rich oil vent tank. Vapor from the vent tank, along with recycle from the fractionator feed tank and deethanizer overhead, is contacted with 193 gpm. of lean oil in the reabsorber at 187 psig. The reabsorber is equipped with one intercooler.

Reabsorber overhead may be used for plant fuel but ordinarily goes to carbon black sales where it is particularly desirable because of its relatively high heating value.

Reabsorber bottoms join flashed rich oil from the vent tank and the combined stream is then exchanged with secondary still bottoms, heated to about 500° F. in the fired heater and fed to the primary still.

The primary still is operated at about 197 psig. and sufficient stripping is accomplished to operate the secondary still totally condensing. Design steam rate is about 1900 pounds per hour. Partially stripped oil from the bottom of the primary still is fed to the secondary still where stripping is completed at 52 psig. Secondary still steam rate is about 7200 pounds per hour. Both stills employ air cooling for condensing reflux and water cooling for final condensation of product.

Secondary still make is pumped to a point just ahead of the primary still product condenser where it, along with second and third-stage compression condensate, enters and aids condensation of primary still net product. Total light hydrocarbon make is accumulated in the fractionator feed tank.

Lean oil end point is controlled by an oil purifier. A small stream of primary still bottoms is fed to the purifier and normally all secondary still stripping steam passes through the unit which vaporizes all but the heavy ends of the oil. The accumulated residue in the bottom of the purifier is periodically drawn off to slop.

Fractionation

Unstabilized liquid product is fed to the deethanizer after being exchanged with debutanizer bottoms and being preheated to 230° F. Three alternate feed trays are provided. Column control is accomplished by a level controller on the reflux accumulator which sets steam rate to the reboiler. Reflux is flow controlled, the design ratio being 1 to 1, reflux to feed.

Deethanizer overhead contains essentially all of the ethane and lighter materials in the feed and enough propane to allow condensation of reflux at the operating pressure, 482 psig. Deethanizer bottoms feed directly to the depropanizer.

The depropanizer operates at 232 psig. and makes propane of about 97 percent purity overhead and an essentially propane-free bottoms. Design reflux ratio is 1.5 to 1, based on feed, and there are three alternate feed trays. Depropanizer bottoms are charged to a caustic contactor for partial removal of mer-

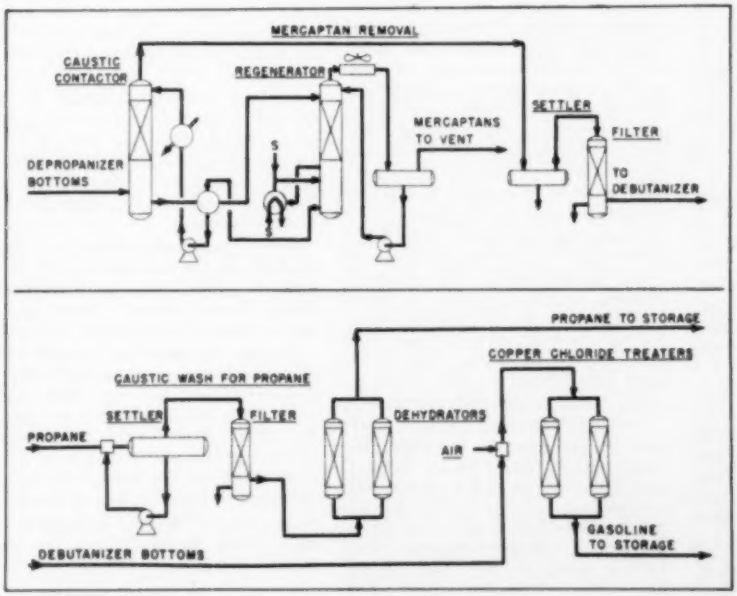
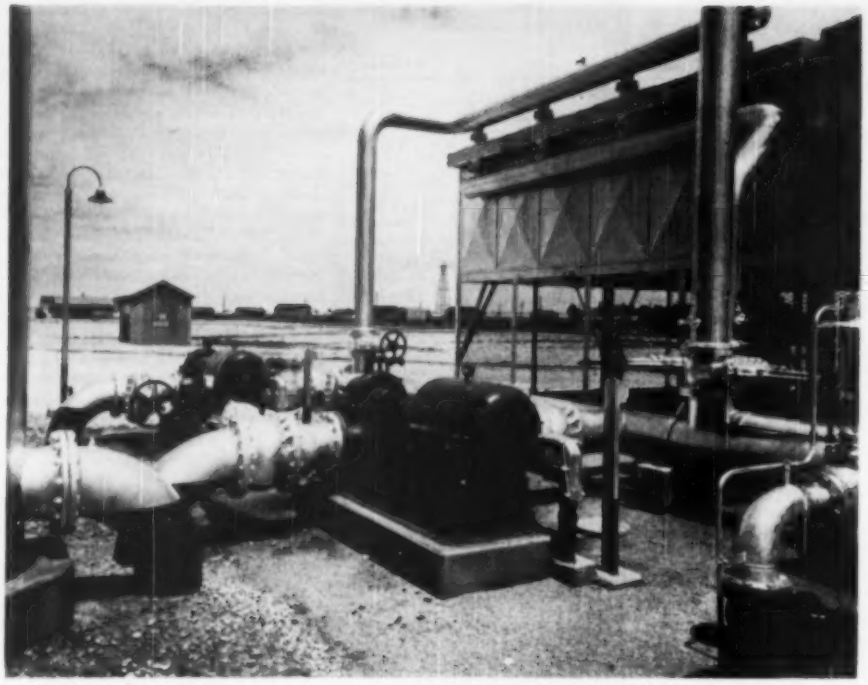


Figure 3. Product Treating, North Cowden Plant.



Two of the electrically-driven centrifugal pumps and an air-cooled unit that provide cooling water for the 1600 hp. compressors.

captans prior to entering the debutanizer. The depropanizer bottoms are exchanged with the cold treated product and cooled to 95° F. with water. After treatment and heat exchange with treater feed, the stream is preheated to 213° F. before being admitted to the debutanizer.

The debutanizer also may be fed on any of three trays. The column is operated to produce 12 to 26-pound Rvp. natural gasoline as bottom product and mixed butanes as overhead. Design operating pressure when making 26-pound gasoline is 117 psig. and reflux to feed ratio is 1.5 to 1.

The depropanizer bottom stream is contacted counter-currently with 10 percent caustic solution which removes about 75 percent of the mercaptans in the raw stream. The treated stream from the contactor flows through a horizontal settler and a sand filter for removal of entrained caustic.

Rich caustic solution from the bottom of the contactor is heated by exchange with hot lean caustic before entering the caustic regenerator near the top. Mercaptans are stripped from the caustic and pass overhead with steam generated in the reboiler. Most of the overhead steam is condensed in air coolers and is returned to the regenerator as reflux. Approximately 10 percent of the total stripping steam is vented with the mercaptans. Lean caustic after exchange is cooled to 95° F. before entering the contactor at a design circulation of about 13 gpm.

The propane product is contacted with a 10 percent solution of caustic in a batch wash to remove traces of hydrogen sulfide. The propane and caustic are mixed in an orifice mixer and flow to a horizontal tank for separation. Propane passes overhead from the settler and through a sand filter before entering solid desiccant dehydrators. Regeneration cycle on the driers is 36 hours and provisions have been made to regenerate with either residue gas or propane vapor.

Natural gasoline product from the debutanizer is treated to doctor specification in solid bed copper chloride treaters. Regeneration air is mixed continuously with the gasoline before it enters the bed. Provisions have been made to treat debutanizer feed in the event that butane product is appreciably contaminated with mercaptans.

Two 42,500-pounds-per-hour water tube boilers generate saturated 300-pound steam. High-pressure steam is used for stripping in the primary still and for heating in the residue gas and propane dehydration units and the remainder is expanded through steam turbine pump drivers. Turbines exhaust into a 90-pound system which supplies the rest of the process heating requirements. There are high and low pressure clean condensate return systems and oily condensate is returned after filtration.

Makeup water is conditioned in a hot lime soda treater which is operated to remove silica as well as to soften the water. The top section of the treater vessel deaerates the entire boiler feed.

Cooling water is furnished by a five cell induced draft tower designed to cool 17,000 gpm. from 96 to 77° F. Facilities for chlorinating and adding acid are provided and a cold lime treater is installed for treating cooling tower makeup.

The plant electrical load is carried by five gas-engine-driven 800-kw., 4160-volt, three-phase generators. Generators have a separate closed jacket water system using air cooling.

Storage includes three 12 x 120-foot cylindrical propane tanks, four 10x 98-foot cylindrical butane tanks and three 5000-barrel spheroids for gasoline. Most of the gasoline and some of the butane leave the plant by pipe line. There are also truck loading facilities at the plant and a rail loading rack south of Odessa, Texas, about 15 miles from the plant. Propane and butane are pumped directly from the plant into tank cars at the rack.

Nomograph for ORIFICE CALCULATIONS

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ORIFICE meters are among the most widely used flow-measuring instruments in industry today. Therefore, it is a frequent task of plant engineers to design meters of this type. The calculations involved in such design problems are usually quite tedious and time-consuming. Thus, any short-cut or simplification in the procedure of calculation should be of value to the engineer using it. It is with this aim in view that the accompanying nomographs have been developed and are presented here.

THE basic equation that relates the rate of flow of fluids through an orifice, the pressure or head drop across the orifice, and the relative size of the orifice compared with the size of the pipe through which the fluid flows is:

$$V_1 = \frac{Q}{S_1} = \frac{c\sqrt{2g\Delta H}}{\sqrt{1-\left(\frac{d_o}{d_i}\right)^4}} \qquad (1)$$

(See Nomenclature)

After rearranging this equation and substituting more commonly used engineering terms and units to facilitate the solution of orifice design problems, equations (2), (3), and (4) are obtained. The accompanying nomographs enable these latter equations, as well as equation (5), to be solved conveniently in a minimum of time. These equations are applicable to sharp-edged orifices: (See Nomenclature.)

$$\left(\frac{d_o}{d_i}\right) = \left[\frac{1}{1+67.57\,R\left(\frac{c}{V_1}\right)^2}\right]^{1/4} \qquad (2)$$

$$\left(\frac{d_o}{d_i}\right) = \left[\frac{1}{1+404.9\,R\left(\frac{cd_i^2}{q}\right)^2}\right]^{1/4} \qquad (3)$$

$$\left(\frac{d_o}{d_i}\right) = \left[\frac{1}{1+7.24\,R\left(\frac{cd_i^2\rho}{w}\right)^2}\right]^{1/4} \qquad (4)$$

It may be noted that R in the above equations has units of "inches of mercury differential under water," so that it becomes necessary to express the manometer differential being used in the particular case in these units. To expedite this conversion the following equation or the accompanying nomograph that solves the equation, may be used:

$$R = \frac{R'}{12.6}(S.G._M/S.G._F - 1) \qquad (5)$$

where R = manometer differential reading, inches mercury under water,

R′ = manometer differential reading, inches manometer fluid under the fluid being metered,

$S.G._M$ = specific gravity of manometer fluid actually used (at same temperature as sp. grav. of fluid in pipe determined),

$S.G._F$ = specific gravity of fluid flowing through pipe (at same temperature as sp. grav. of manometer fluid).

Finally, it should be pointed out that the orifice coefficient of discharge c, is a function of the ratio d_o/d_i, and the Reynolds number in the orifice. For sharp-edged orifices with throat taps this coefficient may be found in the literature[2] plotted versus the Reynolds number. Design procedure usually followed, however, involves the assumption that the Reynolds number in the orifice is greater than 30,000, in which case the value of c is 0.61, which is specially designated on the nomograph. After the ratio d_o/d_i has been found, this assumption may be checked by calculating the Reynolds number in the pipe by means of a nomograph in the literature.[1] The value of the Reynolds number in the orifice is the product of d_i/d_o and the Reynolds number in the pipe. Finally, a more nearly correct coefficient may be found[2] and a new orifice diameter calculated.

NOMENCLATURE

- V_1 — velocity in pipe, ft/sec.
- Q — rate of flow, ft³/sec.
- S_1 — cross-sectional area of pipe, ft².
- c — orifice coefficient of discharge.
- g — gravitational constant, 32.17 ft/sec².
- ΔH — difference in static head before and after orifice as measured by orifice taps, ft. of pipe fluid.
- d_o — orifice diameter, inches.
- d_i — internal diameter of pipe, inches.
- R — manometer differential reading, inches mercury under water.
- q — volumetric flow rate, gallons/min.
- ρ — density of fluid in pipe, lbs/ft³.
- w — weight rate of flow, lbs/min.

An example will illustrate more completely the exact use of the nomograph:

It has been determined that the rate of flow of lean absorber oil to a high-pressure absorber operating at 60° F. is to be 319 lb-mols per hour. The oil is 42° API (sp. gr. = 0.8156 at 60° F.), and its viscosity is 2.0 cp. The mean molecular weight of the oil is taken as 160. The flow rate of the oil in the 4-inch standard steel (nominal size) lean oil line is to be measured employing a differential manometer with water as the manometer fluid. What size orifice should be installed in the line if the desired manometer reading is 30-inch water-oil differential? Throat taps will be used.

$w = \frac{319 \times 160}{60} = 851$ pounds per minute.

$\rho = 0.8156 \times 62.4 = 51$ pounds per cubic foot.

$d_i = 4$ inches nominal.

Assume Reynolds number in orifice to be greater than 30,000: c = 0.61.

$S.G._M/S.G._F = 1.0/0.8156 = 1.226$

Referring to Manometer Reading Conversion Nomograph:

Connect R′ = 30 inches with $S.G._M/S.G._F = 1.226$ and read R = 0.54 inch Hg-H_2O differential.

Now, using Orifice Calculations Nomograph:

Connect 51 pounds per cubic foot on ρ scale with 851 pounds per minute on w scale, and mark the point of intersection on the q scale. Connect this point with 4 inches (nominal) on the d_i scale, and mark the point of intersection with the V_1 scale. Next, connect this point with 0.54 inch on the R scale and mark the point of intersection on the A line. Finally, connect this point with 0.61 on the c scale and read the value of d_o/d_i as 0.810.

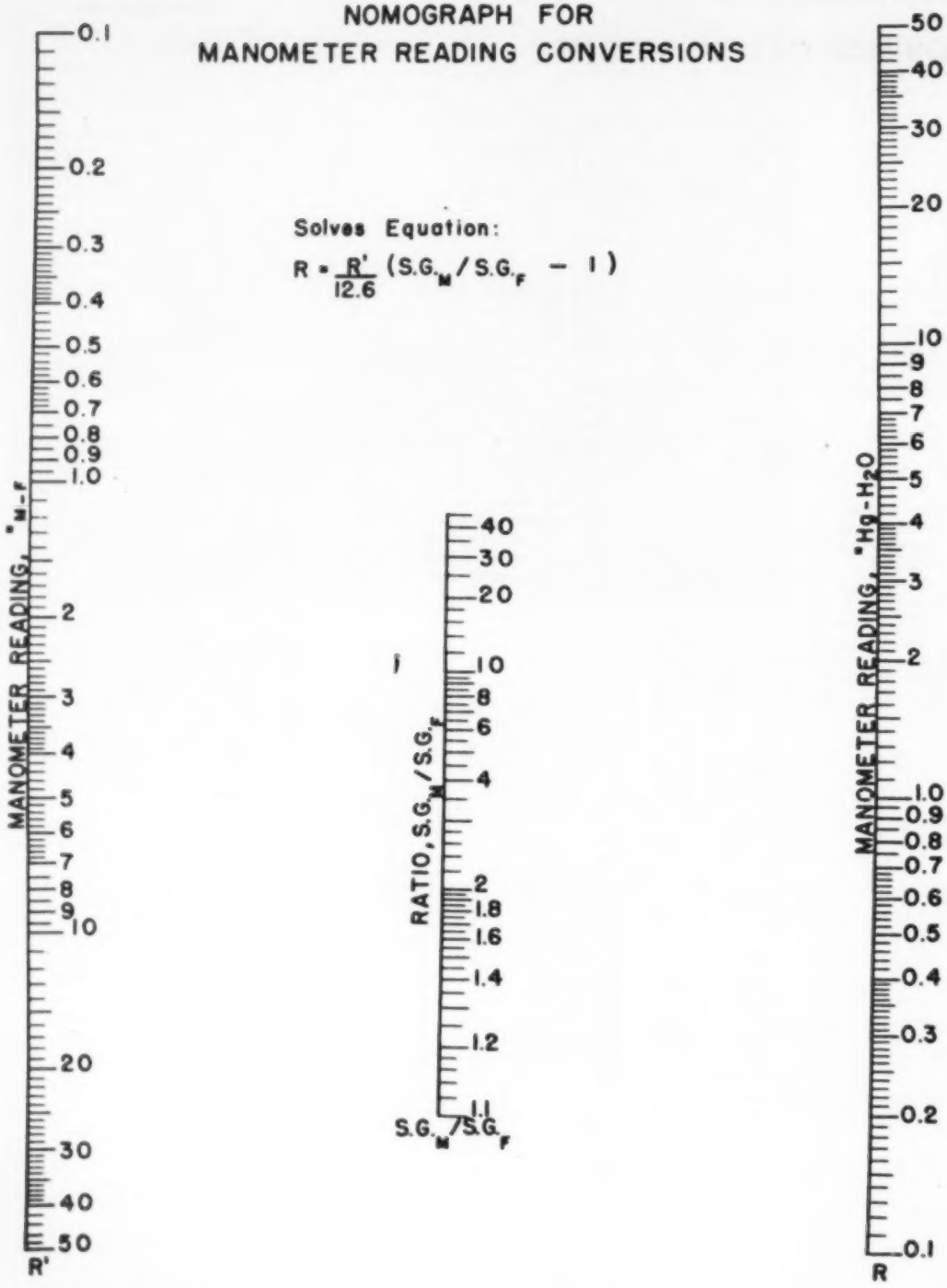
Therefore, the orifice diameter should be: $0.810 \times 4.026 = 3.26$ inches.

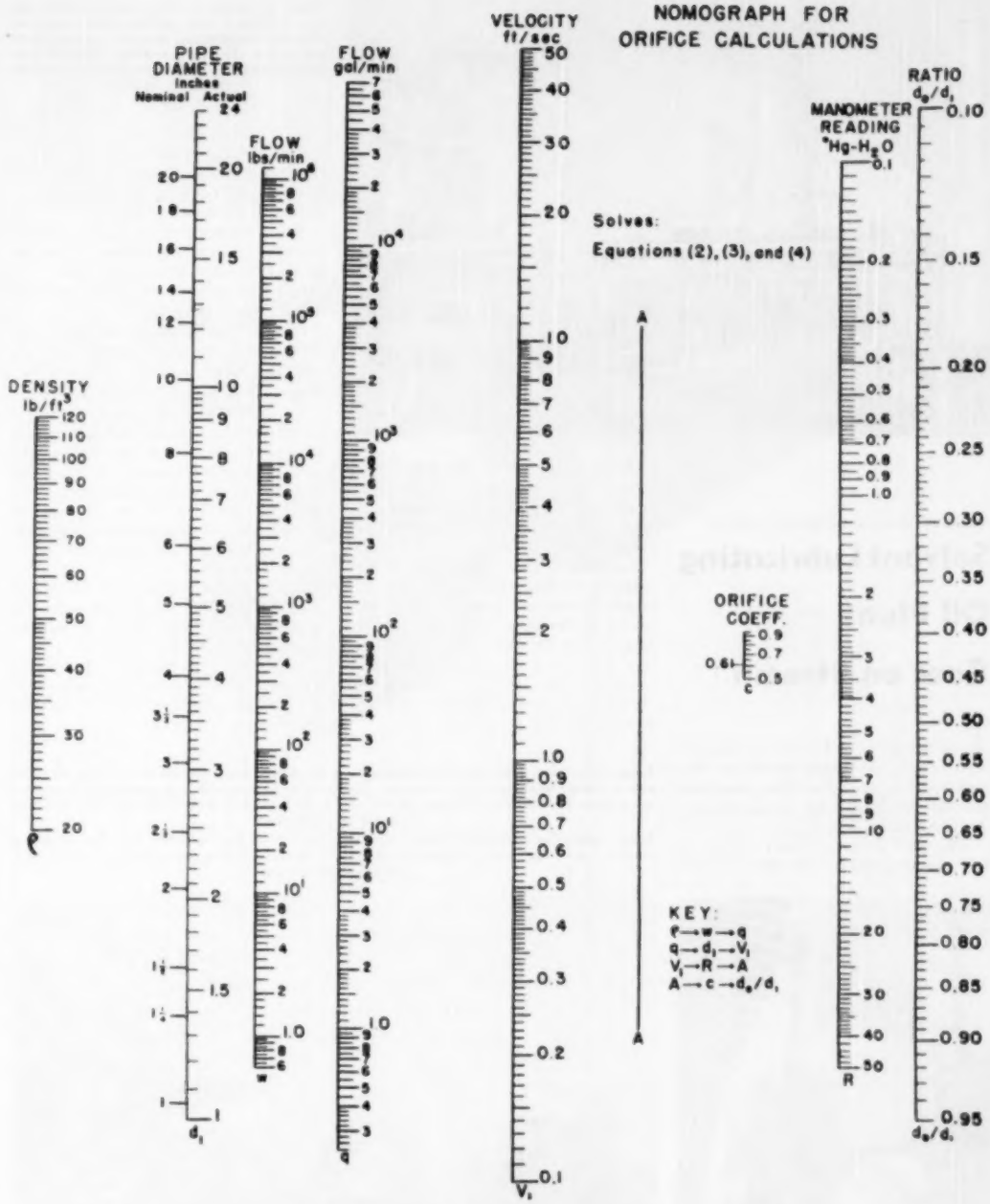
The value for the ratio, d_o/d_i as calculated by Equation (4) is 0.805, and

NOMOGRAPH FOR MANOMETER READING CONVERSIONS

Solves Equation:

$$R = \frac{R'}{12.6}\left(S.G._M / S.G._F - 1\right)$$





the corresponding orifice diameter is 3.24 inches. The Reynolds number in the pipe may now be found,[1] after which the Reynolds number in the orifice can be determined. The latter Reynolds number is calculated to be 49,500, so that the orifice coefficient 0.61 is the correct one to use.

Any values, such as V_1 or q, may be read off the nomograph as the orifice calculation is made. Also, it is possible to begin the calculation with V_1 or q, if either of these values is known. The key on the nomograph indicates the proper sequence of calculation. Another use for the nomograph would be for the calculation of the rate of flow if the orifice diameter and manometer reading are known.

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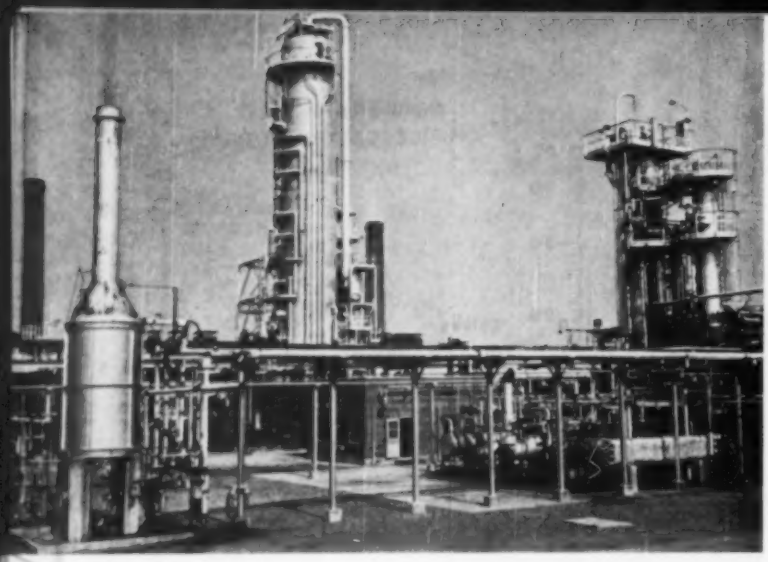
[1] Arnold, T. H., Jr., Petroleum Refiner, March, 1950, page 155.
[2] Walker, W. H., Lewis, W. K., and others, Principles of Chemical Engineering, McGraw-Hill Book Co., New York, 1937, page 81.



Tower in middle is the vacuum distillation unit at Sohio's Lima refinery, while towers on right are the propane deasphalting unit. Both are part of the new lubricating oil plant. The small furnace at left foreground is used to heat the heavy asphalt.

Solvent Lubricating Oil Plant Goes on Stream

THE $13 million new solvent lubricating oil plant, third major unit to be completed here in the $30 million expansion program at Sohio's big Lima refinery, went on stream in mid-July.

The lubricating oil plant comprises five new integrated units and will have a storage capacity of one-half million barrels of oil in 52 tanks. S. R. Bolles is manager of Sohio's Lima refinery and Godfrey Ladd is in charge of the new plant.

Earlier this year, the new $11 million catalytic cracking plant and the new $5.5 million continuous crude-coker were placed in operation. A fourth unit, the central shop building will be completed this month by The H. K. Ferguson Company. The fifth and final unit, the laboratory and office building, also will be completed in August.

E. B. McConnell, vice president of Sohio in charge of manufacturing, stated that the big Lima refinery open house is scheduled for October, when all the units will be in full operation.

The completion of the Lima projects, a part of Sohio's $100 million investment in its three-year modernization and expansion program, is expected to double the refinery's capacity.

Construction of the Lima lubricating oil plant was by the Lummus Company and The M. W. Kellogg Company; the latter installing the de-asphalting unit.

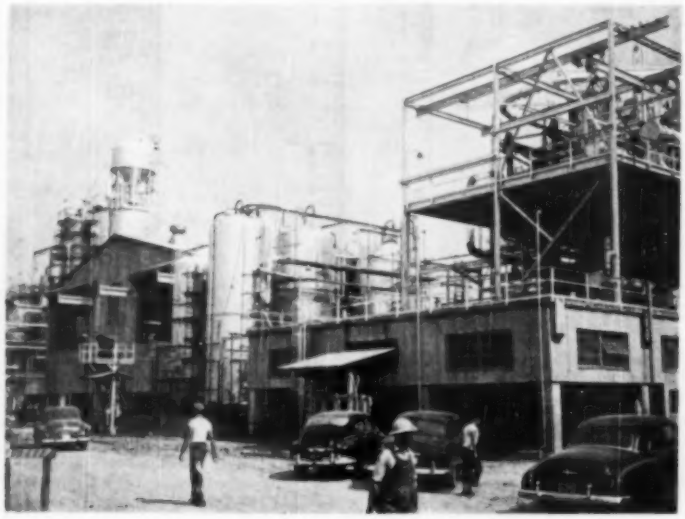
Storage in the lubricating tank field at the refinery will be provided by new air-conditioned tanks. The air in the storage tank is pumped out, dried and replaced in an air-conditioning system. This process reduces condensation to a minimum and eliminates the possibility of any water entering the lubricating oil storage tanks.

The Lima lubricating oil plant will produce 20 different products and has a total capacity of 75,000 gallons of finished lubricating oil per day.

A graphic control panel in the form of a console gives the operator an immediate, graphic picture of all the variables at all times.

Below, left—These twin petrochem furnaces, the centralized heating plant for the lube oil units, heat a continuous stream of oil, whose sole function is to flow through heat exchangers throughout the units to heat up the oils being treated. This is the first application of this principle in the oil industry in a lube plant.

Below, right—The methyl-ethyl-ketone dewaxing unit, shown here, is one of five new integrated units in Sohio's new solvent lubricating oil plant at Lima, Ohio. The clay contact unit is shown in upper left background.



LAGONDA

it's the oldest name in tube cleaning

When the first tube still was erected, Lagonda cleaners were there to take on the cleaning job.

There are fifty constructive years behind the Lagonda cleaner of today. A full half century of development, with all the grief of adventuring up false roads, all the satisfaction of real improvement achieved, that accompany successful pioneering in any equipment. This half century of invaluable experience is today bringing in big dividends to refineries everywhere where — dividends in the form of faster, more thorough tube cleaning, delays eliminated, costly minutes and hours saved in getting stills back on stream.

Put this half century of know-how to work for you. When you have a tough problem, call in the Lagonda man. No obligation.

Here is the refinery tube cleaner that half a century of successful effort has brought forth —the famous LAGONDA 1100 SERIES, ball bearing front and rear handling thrust both ways, fully lubricated in *all* bearings, and demonstrably capable of delivering coke-smashing power that only LAGONDA designed cutter heads can be expected to sustain.

Fully described in the LAGONDA bulletin, on request.

Y-297

ELLIOTT Company

LAGONDA DIVISION • SPRINGFIELD, OHIO

Plants at: JEANNETTE, PA. RIDGWAY, PA. • ANDERSON, IN. J. SPRINGFIELD, O. • NEWARK, N. J. DISTRICT OFFICES IN PRINCIPAL CITIES

Maintenance and Operation

HOW TO DO IT

HOW TO—

Switch Reflux Control Valves

THE control valves shown in the photograph control the reflux stream of a naphtha fractionating column in the Smith's Bluff refinery of the Pure Oil Company, Nederland, Texas. Alternate operations for this tower call for wide variations in the quantity of reflux pumped to the top trap. To maintain adequate control of this reflux stream, to obtain the close fractionation required to make specification products, a choice of two valve sizes has been provided. The valve in service depends on the reflux rate, which in turn is set by the material being charged to the column.

Since one operation requires a large volume of reflux, it follows that the larger control valve is used. Under these conditions pressure drop across a small valve would be needlessly high and a waste of power at the reflux pump would occur. An alternate operation (charging a different material) requires a much smaller flow of reflux. In this case, the smaller control valve is used. At the near open position, this smaller valve has considerable valve plug movement available for controlling the reflux flow effectively. The larger valve, if used at this lower flow condition, would operate with the valve plug very close to the valve seat, or "riding." Also, a very slight movement of the plug would result in a major variation in flow rate. Control would be quite rough and valve chattering a possibility.

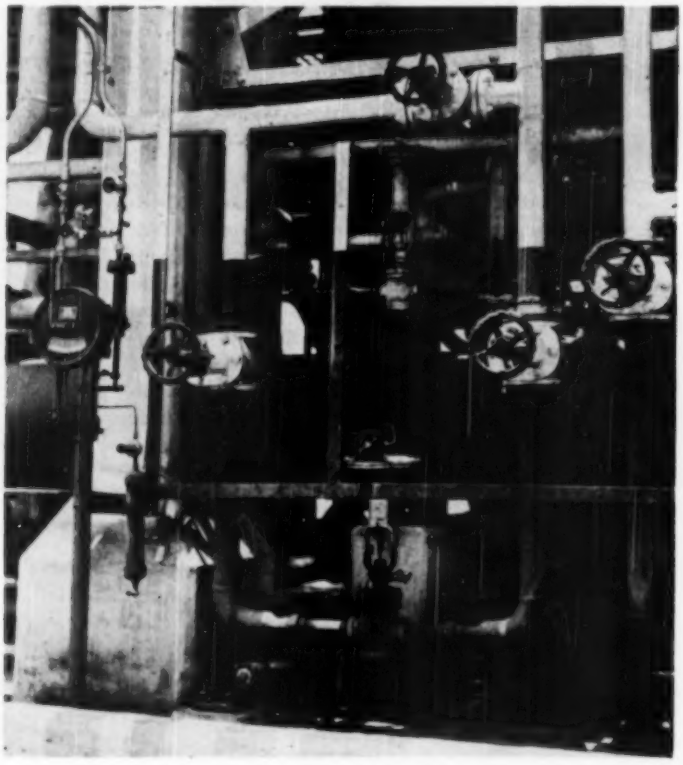
The small valve, mounted on the diaphragm housing of the large control valve, is used to switch air pressure from the controlling instrument to the control valve in use.

HOW TO support flood lamps for maintenance crews at night is illustrated below. The stand was made from material at hand—a barrel ring, three lengths of rod, and a length of 2-inch pipe. When not in use, the cord is coiled and hung on the hook.

HOW TO—

Facilitate Tube Pulling

REMOVAL of tubes from refinery furnaces generally is a difficult and time-consuming operation of maintenance crews. Conventional practice in removing tubes consists of removing the return bend header plug, cutting the tube behind the header, with either a boring bar or an acetylene cutting torch, cutting the tube end out of the header, then fastening a line to the end of the tube by which it can be pulled from the furnace. The most difficult part of this operation is attaching a line to the tube so



DU PONT

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT SERVICES

meet the specific needs of the refiner

IN RESEARCH

IN MANUFACTURING

IN MARKETING

Meet your friends at
THE OIL INDUSTRY SERVICE CENTER
CHICAGO FAIR OF 1950

USE DU PONT TETRAETHYL LEAD COMPOUNDS

These Du Pont Services are Applicable to Your Problems

To aid the refiner in the most effective use of a complete line of gasoline additives, Du Pont provides an extensive service program. The following outline highlights where some of these services are of aid.

IN RESEARCH

Research Helps Match Fuels and Additives to Engine Needs—In the Du Pont Petroleum and other laboratories research effort is being directed at those problems of the refiner which involve development of new fuels and better combustion control.

Problems Under Investigation — Among specific studies being made are the following:

Combustion Reactions — Investigating the chemical changes that take place in the air-fuel mixture under pressure just prior to combustion and during combustion.

Deposit Studies—Research into the chemical nature of engine deposits.

Sulfur in Gasoline—The how and why of sulfur effect upon octane number of leaded fuels.

Effect of Fuel Components on Performance—Research, recently completed, provides information on the blending of fuel components as they affect TEL requirements and performance.

Du Pont Research Is of Use—Significant findings on research projects are made known to refiners:

Through Publication of Papers—Papers on research results are presented at technical society meetings.

Through Meetings with Refinery Research Groups—Members of the Du Pont research staff discuss projects under investigation in meetings with a refiner's own research group.

Company-wide Research – Findings of other Du Pont research laboratories are available at all times to the Petroleum Chemicals Division for consideration as to their application to the petroleum industry.

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IN MANUFACTURING

Aid in the Most Effective Use of Additives—Du Pont provides a complete range of services that function within the refinery.

TEL Blending—Du Pont representatives are thoroughly familiar with requirements as they apply to men, equipment and methods.

Blending Plant Design, Construction—Complete construction drawings and specifications for blending plants, as well as advisory help on plant site selection and construction, are available.

Blending Plant Operation—Du Pont representatives aid in the training of operating personnel.

Maintenance and Repair—Assistance is always available when repairs must be made.

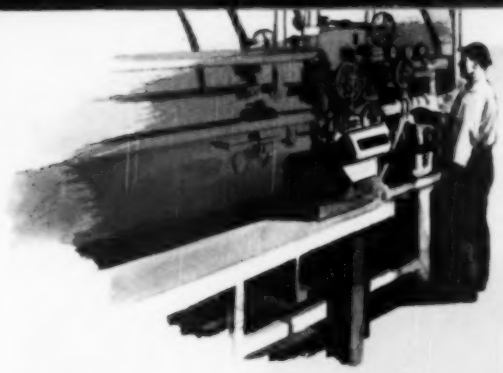
Tank Entries—Petroleum Chemicals representatives will attend and advise on cleaning of tanks that have contained leaded gasoline.

General Refinery Safety Program—An over-all refinery safety program prepared by Du Pont is available to any refiner.

Field Laboratory Services Work on Many Problems—Five Field Laboratories throughout the country assist on problems involving the use of additives.

TEL Blending Studies—These laboratories are equipped to make TEL analyses and blending studies on gasoline stocks.

Octane Ratings—They also make routine octane ratings quickly and accurately.



Gasoline Quality Survey — The laboratories cooperate with refiners in nation-wide sampling and local evaluation of their fuel.

Assistance with Other Additives—Recommendations on the use of Du Pont Gasoline Antioxidants, Metal Deactivator, Gasoline Dyes and other additives are also available through the laboratories.

•

IN MARKETING

Services Helpful in Dealer Training and Sales Planning—These services are designed to supplement and strengthen the individual refiner's own promotional efforts by supplying assistance at those points where it is felt Du Pont can be of most help.

For Dealer Education—To aid you in keeping your dealers better informed on the sales qualities of your fuels, Du Pont offers the following aids:

Informative Talks—Non-technical or semi-technical talks for dealer meetings.

Cartoon Movie—A seventeen-minute, four-color, cartoon movie, understandable to any group, "What Makes A Gasoline Good?"

Cartoon Book—A 16-page cartoon book in full color telling the same story.

Instructive Laboratory Meetings—Tours of the Du Pont Field Laboratories and meetings for refinery sales engineers or marketing groups.

To Aid in Planning Sales—Factual information on gasolines being marketed throughout the country is provided by:

Quarterly Motor Gasoline Survey—Individual brands, premium and regular, are listed by code number together with their motor and research octane numbers, and the lead content per gallon. City averages are also shown.

Other Marketing Aids—Assistance is also available in meeting the problems of your customers.

Traveling Fuel Test Fleet—Demonstrates the importance of gasoline quality to car performance through actual demonstrations of road test techniques.

Services to Fleet and Bus Users of Your Fuels—Du Pont automotive specialists are available for consultation on fleet operating problems or on any problem involving motorized equipment.

Bulletins on Equipment Operation—Based on Du Pont's laboratory and road test experience, bulletins are prepared covering various technical aspects of the equipment used.

Safety Services for Marketing Departments—Du Pont representatives are available for consultation on safety and medical problems wherever tetraethyl lead compounds are used in bulk plants or other marketing department units.

For a complete description of the services which Du Pont offers, ask your Petroleum Chemicals representative to reserve a copy for you of the 32-page book, soon off the press, "Du Pont Services to the Petroleum Industry" . . . or write your nearest Du Pont District Office.

DU PONT SUPPLIES A *Complete* LINE OF ADDITIVES FOR GASOLINE

TETRAETHYL LEAD COMPOUNDS

Du Pont Tetraethyl Lead Compounds, Aviation Mix and Motor Mix, are available on schedule to match your blending needs. Shipments are made in standard drums or tank cars. For the latter service, Du Pont maintains its own fleet of tetraethyl lead tank cars.

GASOLINE ANTIOXIDANTS

Three gasoline antioxidants are obtainable, Nos. 5, 6, and 22. Laboratory evaluation, either in your own laboratory or in the Du Pont Field Laboratories, will demonstrate which one of these three will be the most economical to use in your gasoline.

METAL DEACTIVATOR

Wherever copper, in any quantity, is present in gasoline, the use of Du Pont Metal Deactivator is recommended. It can be demonstrated by laboratory tests, and through actual case histories, that its use, in such cases, materially reduces antioxidant treating costs.

GASOLINE DYES

Du Pont Gasoline Dyes include Oil Red, Oil Yellow N, Oil Orange, and Oil Blue A. To assist in their use, the Field Laboratories provide a comprehensive dye evaluation service.

AND ADDITIVES FOR OTHER PETROLEUM PRODUCTS *AS WELL*

In addition to the complete line of gasoline additives, Du Pont supplies additives for a wide range of other petroleum products. Included among them are fuel oil stabilizers, lubricating oil corrosion inhibitors, grease inhibitors, and the like.

DID YOU KNOW?

That Du Pont has, for many years, supplied special white finishes for gasoline storage tanks? These finishes have maximum heat reflection, and are specially compounded for their resistance to weathering and to provide for self-cleaning properties.

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
PETROLEUM CHEMICALS DIVISION
Wilmington 98, Delaware

District Offices: New York, N. Y.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; Los Angeles, Calif.

District Laboratories: Wilmington, Del.; Chicago, Ill.; Tulsa, Okla.; Houston, Texas; El Monte, Calif.

DU PONT
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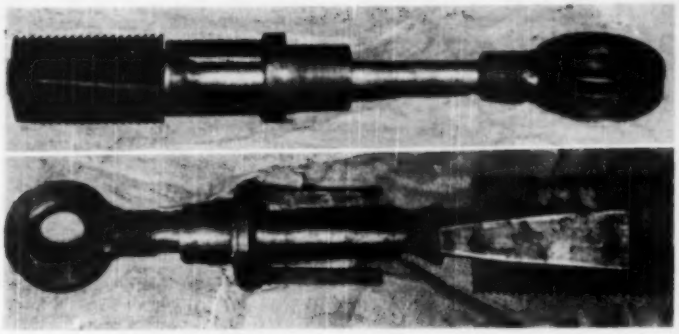
Better Things for Better Living
...through Chemistry

A-836



that it can be pulled from the furnace.

The furnace tube pullers, illustrated in the photographs, were designed to simplify the job. They have been used with excellent results for the past several years in the Smith's Bluff refinery of The Pure Oil Company, Nederland, Texas. Invented by George Hall, foreman in the maintenance department, the tool has been patented and assigned to the company. Since the various furnaces in the plant are equipped with different sizes of tubes, the puller has been made in several sizes to fit the tubes.

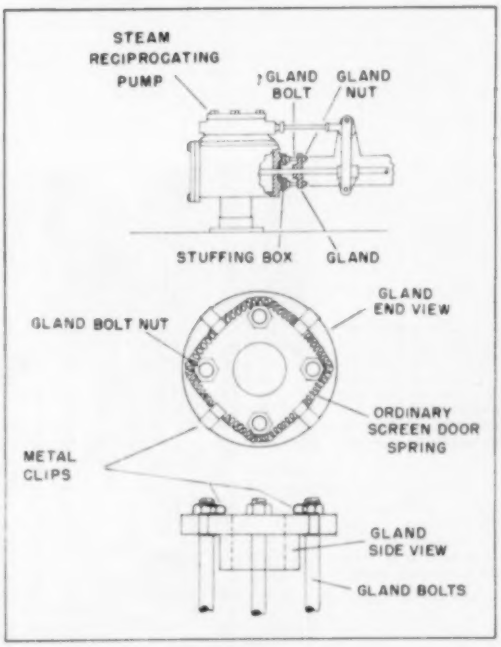
Details of the puller can be seen in the photographs. When the header has been cleared and the tube is ready to be pulled, the puller is inserted in the tube so that the slips are well inside. The mandrel, which slides on the shank of the puller is used to strike the slips to set or release them. Two rods, one on each side of the mandrel, and parallel to the shank, are long enough to reach the slips inside the tube during the setting or releasing operation. Thus, the mandrel forces the slips up the wedge on the end of the shank against the inside wall of the tube.

A line from an air tugger or winch is connected to the shank ring and the pull exerted on the wedge seats the slips. Then the tube is pulled from the furnace. To release the puller from the tube, the mandrel is used to drive the slips loose.

HOW TO—

Secure Pump Packing Gland Bolt Nuts

A METHOD of securing the packing gland bolt nuts on reciprocating and centrifugal pumps is illustrated in the drawings. Since the gland bolts generally are not set up tight, they have a tendency to work loose due to vibration, so that the gland is not maintained against the packing with the pressure necessary to prevent leakage of fluid. A loose gland, in addition to leaking, may cause excessive wear on the packing material and shaft.



The device consists of four sheet metal clips and a spring, such as that used for screen doors, used as illustrated. The clips, evenly spaced, hold the spring against the face of the packing gland flange and in position on the gland bolt nuts. Pressure exerted by the spring on the nuts prevents them from turning and loosening the gland.

The device lengthens the useful life of the packing and prevents leakage and scoring of pump rods and shafts. Also general maintenance is reduced and operating safety of the pump is increased.

This suggestion was submitted by Leon C. Clark, machinist, and Albert C. Smith, machinist's helper. Sketch and material courtesy of "Coin Your Ideas" Committee, Esso Standard Oil Committee, Louisiana Division, Baton Rouge.

HOW TO—

Support Steam Trap

WHEN steam traps are installed on small pipe lines, which do not supply adequate support for the traps, a simple and easily constructed support can be made in the refinery's welding shop from

pipe of internal diameter to fit the case of the steam trap.

In this installation, the pipe nipple was trimmed smooth at the top end for the steam trap. The lower two thirds of the nipple was split and sections removed from both sides, leaving two

legs to rest upon a temporary ground support, such as a piece of timber. While this support is not to be considered as a permanent installation, the temporary use of an adequate support protects the trap and the steam lines to which it is attached.

HOW TO—

Remove Sulfur From Heater Fuel Lines

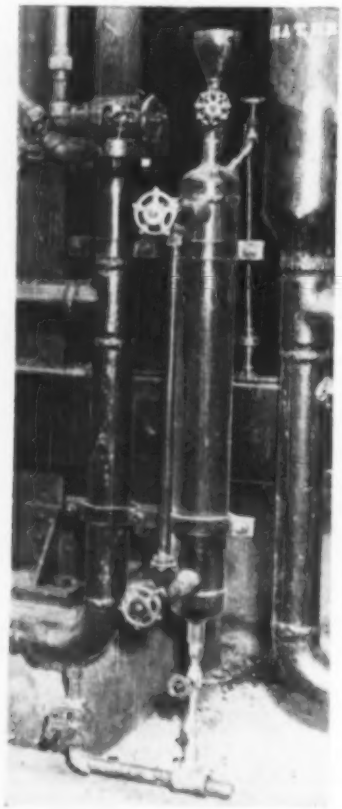
WHEN sour gas is used as fuel for refinery heaters, sulfur deposited in the fuel lines often causes plugging and corrosion of the lines, valves and burners. In the control valve manifolds for the fuel gas system on a large heater, shown in the photographs, depositions of sulfur had been occurring in the horizontal portion of the manifold up stream from the valve and in the burners, which have small orifices.

To prevent plugging and corrosion of the line, a lubricating type device, or desulfurizer, has been installed on the right vertical leg of the manifold. The desulfurizer injects a solvent into the gas stream ahead of the control valve. This solvent, usually kerosene or naphtha, dissolves the sulfur, which then is entrained in the gas stream and carried to the burners.

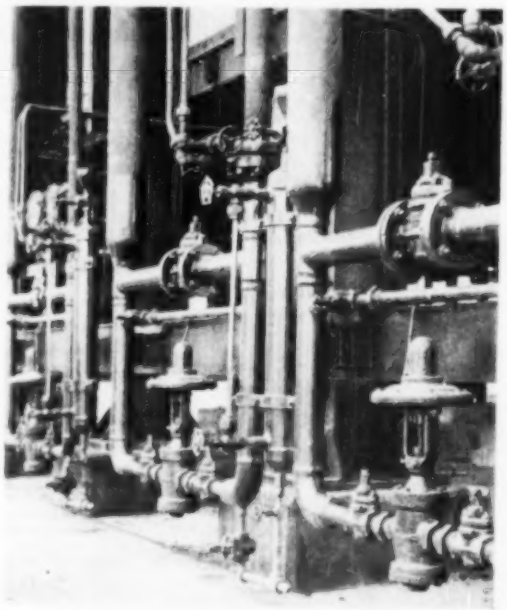
The lubricators were made in the plant shop. As is apparent in the photographs, the lubricator consists of a section of pipe with plugs welded on the top and bottom ends to form a cylindrical tank for the solvent. It is equipped with a sight glass, a filling funnel and valve on the top end, and a needle valve in the bottom connection to provide close regulation of flow of solvent into the line.

When the required rate of injection of the solvent has been determined, the small plug valve is used as a cut-off valve during refilling of the cylinder, and the needle valve is not disturbed. A small line connected to the top of the cylinder supplies gas under sufficient pressure to force the solvent into the fuel line.

Since the control valve manifolds are alongside the operator's walkway, the lubricators have been fastened to the vertical leg of the manifold with the strap iron brackets. The level of solvent in the sight glass is easily checked by the operator on his rounds.



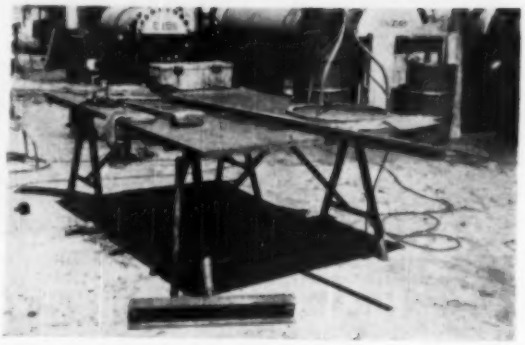
Left—Close-up of the lubricator showing details of construction. The sight glass permits the operator to determine the level of solvent at a glance on his routine inspections.



Right—Installation of the lubricators on the fuel manifolds of a large heater in Pure Oil Company's Smiths Bluff refinery.

HOW TO—

Provide Work Table in Plant Area



WHEN making repairs on various parts of the internal equipment of a bubble tower, one refinery has found that a heavy work table of simple construction that can be set up near the column, provides an excellent surface for the work and is an important time saver.

This table is constructed with a generous size top, made of one-inch thick sheet steel, on supports of tubular steel. The table top is as smooth as can be obtained with this type of material, and approximately flat. Wiers and other sheet metal parts which have been distorted in service, or damaged on removal can be repaired almost at the foot of the column without hauling the material long distances for repair. To hold work and material to the table, "C" clamps are used. A two-inch square piece of bar steel is supplied for making sharp longitudinal bends.

A work table of the type described is shown in the photograph set up in the plant area of a refinery.

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

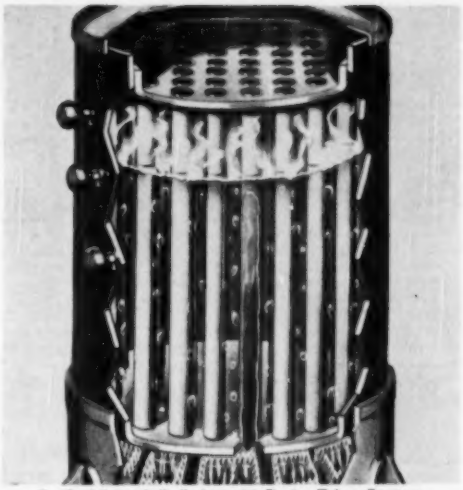
Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Duplex Tubes Boost Life and Heat Transfer Properties of Equipment

Heat exchanger tubes and piping in chemical and petrochemical plants often demand protection against corrosion from a *double-sided attack.*

For this reason, Duplex Tubing (two tubes of different metals mechanically bonded together to form a double-walled tube) has proved its worth in numerous applications.

In handling hydrocarbon gases with a high hydrogen sulphide and or carbon dioxide content, Duplex Tubes — aluminum to the product side and copper to the water side — have proved very satisfactory.



Gas-fired "steamboiler" plant with Duplex Tubes—Courtesy Eclipse Fuel Engineering Co., Rockford, Ill.

Various types of ammonia coolers are giving longer life through the use of Duplex with steel to the ammonia side and a copper or copper-base alloy to the water side.

Typical combinations in the chemical field of Duplex Tubing with copper or a copper alloy to the water or steam side include:

Products	Contact Metals
Formaldehyde	aluminum
Salycilic acid	tin
Sulphuric acid	lead
Ammonia	steel
Lubricating oils	aluminum
Coke and gas by-product liquors	steel
Sea water	cupro nickel

Steam generators for car-heating systems installed on Diesel and electric locomotives and various industrial units can be given greater efficiency and longer life with Duplex Tubing. Steel is used to the flue-gas side, copper or copper alloy to the steam side.

High-Heat Transfer

Tests carried out with steel tubing and with Duplex of steel-copper show that the latter possesses higher transfer properties. This explains why smaller units with Duplex Tubing can often replace larger units containing steel or other low heat transfer materials. A properly selected combination of metals for a particular corrosive service usually results in improved heat transfer. The Bridgeport Laboratory will be glad to help select the materials best suited for your application.

New Duplex Tubing Bulletin

Helps Solve Double-Corrosion Problems

Corrosion, always a serious problem in heat exchange equipment, is especially troublesome when tubing is attacked simultaneously inside and outside by two entirely different corrosion media. Bridgeport's Duplex Tubing is designed to solve this particular problem since it provides a combination of two different metals to cope with the specific corrosive conditions on inner and outer surfaces. Duplex Tubing is finding widening application in heat exchange equipment used in oil refining, chemical, food and liquor processing, power plants, refrigeration, heating and air conditioning.

As an aid in the selection and application of Duplex Tubing of various alloy combinations, Bridgeport has just published a new Duplex Tubing Technical Bulletin No. 1950. This deals with the advantages of Duplex Tubing in ammonia refrigeration, steam generation, oil refining, natural gas, chemical and petro-chemical processing and the alloys suited to handle various corrosive media.

We will be glad to send your copy of "Duplex Tubing Technical Bulletin No. 1950." Please send request on your company letterhead.

Complete information on the improved heat transfer properties obtained with Duplex Tubing is included, together with data on its use at higher temperatures; the sizes and tempers available; and the various alloy combinations supplied. Particularly useful to the condenser and heat exchanger manufacturer or maintenance department is the complete section on installation of Duplex Tubing.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • *ESTABLISHED 1865*

Mills at Bridgeport, Connecticut, and Indianapolis, Indiana • In Canada: Noranda Copper and Brass Limited, Montreal

REFINER AUTHORS
and Other Personalities

Exalted Ruler Rates Low As Boatman

"MAINTENANCE and Repair of Refinery Control Valves," the article with which this author, well-known in the industry, is concerned, begins on page 77.

Four years after the turn of the 20th century, W. H. (Mac) Fortney became a native son of Warren, Ark. By 1925, he had completed grammar school at Mineral Wells, Texas, high school at Austin, Texas, studied electrical and chemical engineering at the University of Texas, and entered the employ of Humble Oil & Refining Company at Baytown. After nearly a year, he left to see something of the art of refining in distant places. He returned to Humble after an absence of two years, during which he worked for The Texas Company at Port Arthur, and Crown Central Petroleum Company as foreman of the electrical and instrument construction work. During 1929-30 he worked at Humble's McCamey refinery in West Texas. He has been at the Baytown refinery since that time, and has been foreman of the instrument department since 1937.

Fortney is one of the most popular foremen in the refinery. He also is well known to the town's people. He was a candidate for mayor of Baytown in 1947, president of the Water District of Baytown before incorporation of the city, and has served as a member of the board of Directors of Welfare League and Health Clinic (Community Chest activities). He is also a member of the Community Recreation Committee.

He is a past exalted ruler of the Elks and has participated in two national contests on ritualistic work.

As chairman of the convention committee for the Sixth National Conference and Exhibit of the Instrument Society of America, scheduled for Houston, Sept. 10-14, 1951, Fortney believes the meeting probably will be the largest technical convention ever held in the South. He is chairman of the recommended practices committee of ISA, the busiest committee of the society. Fortney was first president of the Houston Section of ISA. Also, he has been a member, since organization, of the steering committee for the "Symposium on Instrumentation for the Process Industries" held annually at Texas A. & M. College.

Fortney has presented papers before ISA meetings in New Jersey, Ohio, Illinois, and Texas. He has written and published some fifteen article in technical and trade publications. He is patent holder on a gravity recorder for liquids.

Besides his family and many friends, Fortney reputedly has three hobbies—his work, Mrs. Fortney's floral shop, and fishing for trout and redfish. Friends say that Fortney will go early and stay late when the fishing is good. It has been reported that Fortney is not at all helpful in a boat having engine trouble in rough water.

Mrs. Fortney became so interested in her hobby of flowers, that she opened a small shop, which has prospered quite well. With flowers all around him Fortney soon found himself with another hobby. Almost his entire vacation was spent at a floral design school, and as he says, "I'm in flowers up to my neck and love it!"

Fortney and Mrs. Fortney are parents of three children—two daughters and a son. Mrs. Fortney and the daughters, one of which is married, are talented pianists. One daughter is a concert pianist. The Fortneys will be grandparents soon.

LPG Unit Author An Honor Graduate

HOWARD F. Thompson, whose article "Refinery LPG Unit Employs Steam Jet Vacuum Refrigeration" appears on page 105, joined Sinclair Refining Company at the Marcus Hook, Pa., refinery in 1929 while a cooperative engineering student at the Drexel Institute of Technology. After graduation with honors from the chemical engineering division, he worked in the operating and technical divisions of the refinery in various capacities until he was made chief technician in 1945.

During World War II, in addition to refinery duties, Thompson taught graduate engineering groups government sponsored courses on principles and economics of chemical plant design.

Thompson is a member of the American Institute of Chemical Engineers, Pennsylvania Sewage and Industrial Wastes Association, and Pennsylvania Society of Professional Engineers. He is active in local and state levels in the Pennsylvania Engineers group.

Design Engineer Boosts California

JAMES A. Davies, who presents on page 92 Part I of "Bubble Tray Design and Layout," has been designing a variety of refinery units ever since his first association with The Texas Company, engineering division, New York.

Davies at first worked as a roustabout for The Superior Oil Company near Bakersfield, Calif. after receiving a B.S. in 1935 from California Institute of Technology. Later he went back to school, this time for his masters degree in chemical engineering from Caltech.

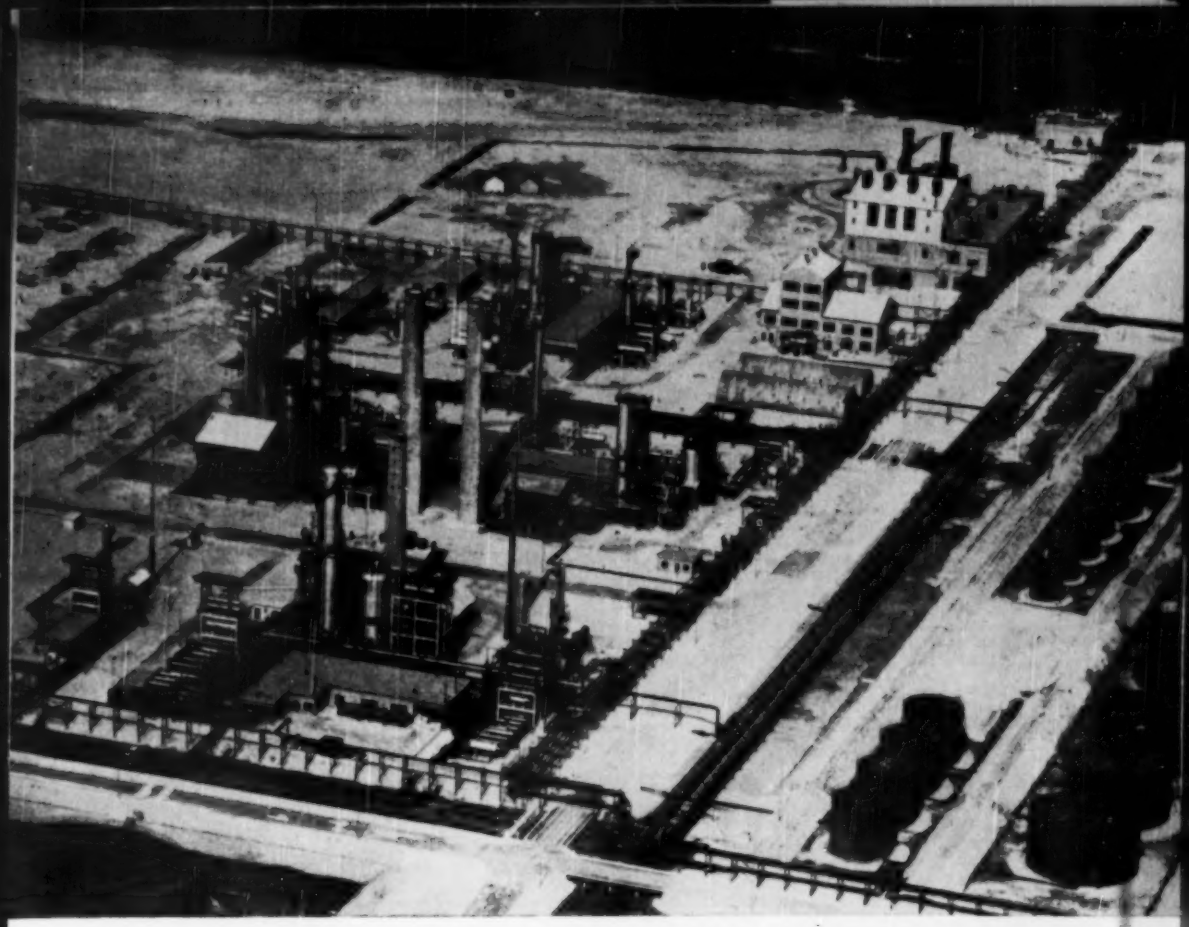
Born in 1914 in Salt Lake City, Davies says he grew up on the beach of Santa Monica, Calif.—with three years taken out for attending school in England. He later married a Yankee and now has two young daughters—neither interested in engineering—one four and the other six years old. Outside interests include gardening, bridge, tennis, boosting California, and the Lions Club. Davies is a member of AIChE, ACS, ASME, and Tau Beta Pi.

They Tell How To Use Flue Gas

CO-AUTHORS Kenneth M. Brown and Soma Kurtis present on page 111 their article "Difficult Waste Disposal Problem Solved." Brown is with the treating division of the service department of Universal Oil Products Company, where his work involves technical service for licensees of UOP processes and for users of UOP inhibitors. He joined UOP shortly after receiving his B.S. in chemical engineering from the University of Wisconsin.

Kurtis, now doing process engineering work with Aurora Gasoline Company, Detroit, was formerly chemist in their laboratory. His first job in the U. S. as a chemist for Kellogg Chemical Com-

W. H. FORTNEY | H. F. THOMPSON | JAMES A. DAVIES | K. M. BROWN | SOMA KURTIS



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pany, Detroit, manufacturers of insecticides and industrial cleaners.

Kurtis, born in Leipzig, took all pre-university schooling in Germany. In 1933 he enrolled at the University of Turin, Italy, in chemical engineering. In 1935 he transferred to the University of Naples, Italy, and continued studies in chemistry. From here he was graduated with a Ph.D. degree in chemistry in 1938.

Kurtis' outside interests include besides his four-year-old daughter, classical music, literature, and travel—both near and far.

Process Engineer Likes Gardening

M. H. RAHMES, author of "Sour Gas—New Plant Operation MEK, Dehydration, Caustic, and Copper Chloride Units," page 118, is process engineer with the manufacturing department of Stanolind Oil and Gas Company working primarily on the design and start-up of gasoline plants.

Rahmes graduated from the University of Cincinnati in 1940 with a degree in chemical engineering and worked for Ashland Oil and Refining Company for about one year before joining the army. After release, he attended the University of Tulsa and received a master of science degree in 1947. Since then he has been with Stanolind.

Outside activities, he says, are taken up with a little amateur gardening and collecting records. Rahmes is a member of the AIChE, Tau Beta Pi, and Alpha Chi Sigma.

Sittig in Detroit

MARSHALL Sittig, who offers on page 99 the second part of his extended discussion of "Catalytic Cracking," is at present doing technical writing and editing for the research department of Chrysler Corporation, Detroit. Previously he was engaged in chemical engineering studies for a paper manufacturer in Maine.

Part I of the series appeared in the June REFINER. Another Sittig article, "Fired Heaters for Petroleum Refining," was featured in August, 1949.

A new addition to Sittig's family of two small daughters is a boy—aged four months—a junior petroleum technologist, according to Sittig.

Shell Pair Discuss Analysis Methods

"REDUCED-SCALE Methods for Micro and Semimicro Organic and Inorganic Analysis," the article beginning on page 85 in this issue of PR, was written by Louis Lykken and Thomas D. Parks of Shell Development Company in California.

Louis Lykken, a native of South Dakota, was graduated in chemical engineering from the South Dakota School of Mines and Technology in 1927. At Iowa State College, he received his Ph.D. in physical chemistry in 1933, and served as a member of the faculty from 1927 to 1938. This was in the fields of chemical analysis, instrumental analysis, and physical metallurgy. During this time, he was general consultant on analytical and chemical problems.

In 1938, he headed west to Shell Development Company's analytical department and became assistant department head in 1943. He has been concerned with the analysis of petroleum products and with development of methods for potentiometric, polarographic, colorimetric, and combustion analysis. In this field, he is co-author of numerous publications. He has been active in the work of Committee D-2 of the American Society for Testing Materials since 1940.

While he finds some time for his hobbies involving geology, traveling, and music, most of his leisure time is devoted to his family of five children and one grandchild. He and Mrs. Lykken live in Berkely.

Thomas D. Parks was born in Alberta, Canada, 1917. His early education was received in Detroit, and Vancouver. He is a graduate of Wheaton College, 1942, in chemistry. He did graduate work at the University of Illinois, majoring in analytical chemistry. He gained his Ph.D. degree in 1945 and remained at Illinois to work on the Government Synthetic Rubber Program as an analytical research chemist.

From the end of 1945 to August 1949, Dr. Parks was a member of the analytical department of Shell Development Company, his chief interest being in the fields of instrumental and microchemical analysis. After a short business trip to the Philippine Islands, he assumed his present position as head of the analytical chemistry section of the department of chemistry and chemical engineering of Stanford Research Institute. He is co-author of several papers on various phases of analytical chemistry with emphasis on instrumental methods of analysis.

Danny, David, and Dick, lively boys of Dr. and Mrs. Parks, manage to occupy most of their parents' leisure time. Dr. Parks does get time off to fish for striped bass and an annual abalone hunting trip.

Economists Make Annual Analysis

"OIL Industry Makes Effective Use of Its Capital Setup," this issue's economic feature on page 67 is based on "Financial Analysis of 30 Oil Companies," a survey by Dr. Joseph E. Pogue and Frederick G. Coqueron, which analyzes the financial transactions of about two-thirds of the U. S. petroleum industry. The study has appeared annually for the past seven years.

Pogue, one of the foremost oil economists, has been, since January of this year, petroleum consultant to the Chase National Bank of New York. Since 1936, he was vice president in charge of the petroleum department. Coqueron is analyst of the bank's petroleum department having previously been consultant for Tide Water Associated Oil Company, New York, as also was Pogue.

Pogue holds A.B. and M.S. degrees from the University of North Carolina, his Ph.D. degree from Yale University, and was a special student at the University of Heidelberg. He is a member of Phi Beta Kappa.

Pogue has served as member, executive, or in advisory capacity on many government committees including the Interstate Oil Compact Commission, Petroleum Industry War Council and its National Oil Policy Committee, and the Congressional Subcommittee on business profits. Besides the financial analyses, he is also author of three books on the industry and contributor of numerous articles to industrial publications.

Coqueron was graduated in 1922 from Columbia University with a B.S. degree. From 1923 to 1936 he was with Tide Water in New York where he was statistician, specializing in accounting and budgetary matters. In 1936 he was invited by Pogue, to join the staff of the newly organized petroleum department of the Chase.

Coqueron lives in Westfield, N. J., with his wife and two children, a son, 19, and a daughter, 15.

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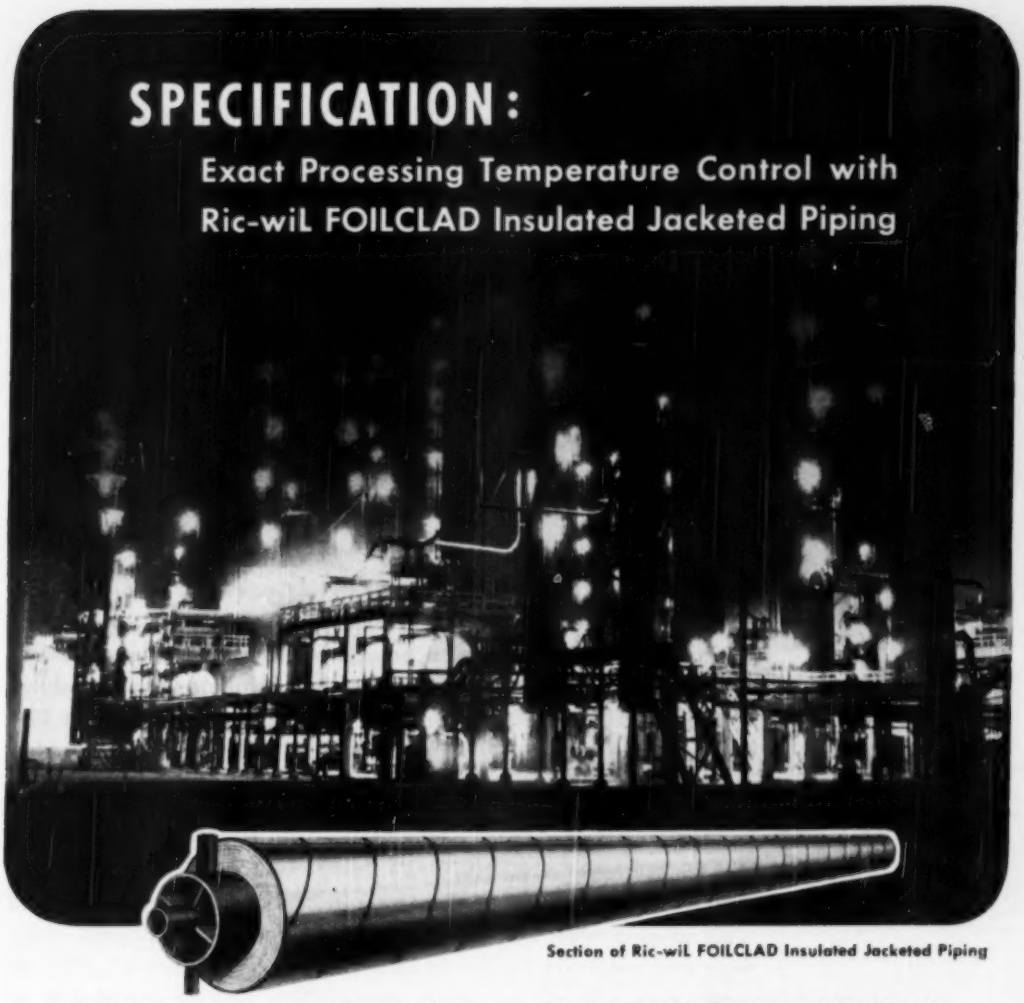

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The MONTH... in the INDUSTRY

Korean Activity Forces Attention Of Industry on Avgas and Jet Fuel

A large increase in military oil demand and return of some controls were indicated for the U. S. in President Truman's speech of last month. He thought then that there is no need for price controls and rationing if government and the public exercise great restraint in the use of those goods and services which are needed for increased defense efforts.

While total effect of the military's accelerated oil purchase program to date on account of the Korean war has been to increase regular needs by 1 to 2 percent, (figures on the annual basis), a good chunk of the $10 billion preparedness program asked of Congress is meant to cover more expansive requirements, including principally aviation gasoline and jet fuel.

A Real Bind

As a result of the military avgas requirements, the refining industry will be in a real bind by the end of this year according to Bruce K. Brown, chairman of the military petroleum advisory board. The government must take drastic steps to meet the situation which has resulted from only partial mobilization, he said. The chief threatening bottleneck is a shortage of alkylate. At the end of World War II there were 56 alkylation plants, but now there are about 40. These should be run at 100 percent capacity, according to Brown.

The National Petroleum Council has already set up committees to help the military solve its immediate emergency supply problems and to advise government on industry's need for steel to maintain production at required levels, the adequacy of oil and transportation, and distribution, and extent of available storage capacity in industry tankage. The Interior Department is to have administrative responsibility over petroleum supplies in any emergency, according to W. Stuart Symington, chairman of the National Security Resources Board, implying that for the present, Interior's OGD will function as central oil agency in Washington. Presumably, if world events lead to an all-out war, any future PAW would also be under Interior Department jurisdiction, the scope of which will be outlined when Congress acts on President Truman's control bill and his call for funds to implement that measure.

Men to run the government's oil "machine" will be drawn from industry to the extent that such a "machine" is necessary, Interior Chapman told the NPC. OGD has a request on file with Budget Bureau for sufficient funds to permit hiring of up to 25 oil "specialists" who would be recruited mainly, if not entirely, from industry.

Manpower Problem

The head of every oil company, says OGD Director Stewart, should immediately review his individual company's manpower requirements in light of increasing military calls for personnel who are in the organized reserves (both officer and enlisted) and certain heavier drafting of men by selective service. Meantime, the Defense Establishment is hoping to formulate a temporary policy respecting deferment of key men in critical industries such as oil.

NPC's reactivated Steel Requirements Committee met in Washington August 2 for the purpose of organizing and agreeing on methods to be used in determining amount of steel needed for maintaining adequate supplies of oil and natural gas. The committee will also deal with problems delegated to NPC's petroleum transportation and Petroleum Storage Capacity Committees.

Members of the Steel Requirements Committee as appointed by NPC chairman Walter S. Hallanan are as follows: K. S. Adams, Phillips Petroleum Company; Hines H. Baker, Humble Oil & Refining Company; Warren S. Churchill, American Association of Oil Well-drilling Contractors; Stewart M. Crocker, Columbia Gas System; J. C. Donnell II, The Ohio Oil Company; Fayette B. Dow, National Petroleum Association; R. G. Follis, Standard Oil Company of California.

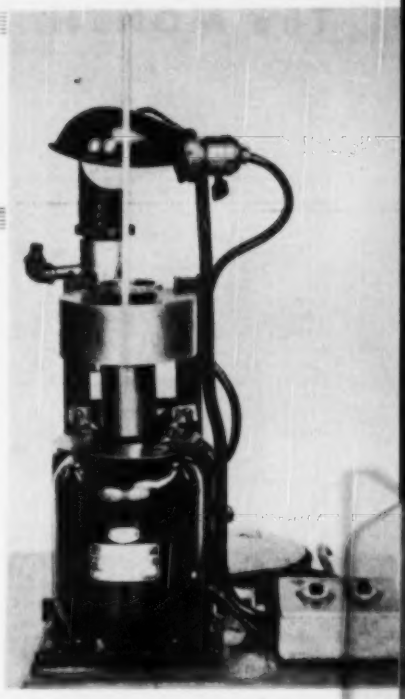
Robert L. Force, Texas Independent Producers Royalty Owners Association; R. C. Graves, Union Tank Car; R. H. Hargrove, Texas Eastern Transmission Corporation Corporation; Harry B. Hilts, Atlantic Coast Oil Conference; Eugene Holman, Standard Oil Company (New Jersey); D. A. Huley, Lone Star Gas Company; R. R. Jennings, Socony-Vacuum Oil Company, Inc.; William M. Keck, Jr., The Superior Oil Company; R. L. Majewski, Deep Rock Oil Corporation; L. F. McCollum, Continental Oil Company; N. C. McGowen, United Gas Pipe Line Company; S. F.

Avgas Yields Being Boosted

Refinery production of the two highest grades of aviation gas at a rate of approximately 70,000 barrels per day will be boosted during the balance of 1950 to meet present best estimates of military demand. About half of the requirement will be for grade 115-145, demand for which has increased 30 to 40 percent since July 1.

Frank M. Porter, president of the American Petroleum Institute, said that the petroleum industry is fully prepared to meet any and all foreseeable military emergencies with which this nation may be confronted. Porter pointed out that production in the U. S. alone could be immediately stepped up to over 6 million barrels a day without injury to the producing formations.

Interior Secretary Chapman appealed to all refiners who are blending alkylate into civilian motor fuel saying they should "seek to purchase such substitute blending stocks as may be necessary to sustain motor gasoline quality, thus eliminating the use of aviation alkylate in motor gasoline; then either blend aviation gasoline for the military or sell the alkylate to other blenders." He specifically requested refiners currently blending grade 115-145 to endeavor to purchase additional alkylate so as to increase production.



GREASE TESTING MACHINE DEVELOPED— To analyze performance of greases in ball and roller bearings over a wide range of temperatures, research scientists of The Texas Company last month announced development of a grease testing machine that simulates actual service conditions.

By observing grease samples in the machine during test—under high-speed stroboscopic light—it is possible to determine changes in quality, texture, consistency and color. The machine also reveals grease tendencies toward aeration, leakage and breakdown through heat and prolonged use.

The machine consists of a high speed motor-driven shaft which operates a single-shielded ball bearing encased in an electrically heated oil bath. Temperature of the bath can be regulated from room temperature up to 300° F. and higher—indicated by a thermometer inserted in the bath well.

Test procedure starts with a charge of 5 grams of test grease to the bearing. The greased bearing is put into the machine and the test is run for three minutes before the heater is turned on. Observation of the grease sample is made at 25° increments in temperature under stroboscopic light while the machine is running at 3450 rpm.

The MONTH...

Nitues, National Tank Truck Carriers.

Frank M. Porter, American Petroleum Institute; Walter R. Reitz, Quaker State Oil Refining Corporation; A. E. Ritchie, independent producer; W. S. S. Rodgers, The Texas Company; A. H. Rowan, drilling contractor; W. G. Skelly, Skelly Oil Company; Reese H. Taylor, Union Oil Company of California; G. A. Thompson, Petroleum Equipment Suppliers Association; J. Ed Warren, Independent Petroleum Association of America; Robert E. Wilson, Standard Oil Company (Indiana); and H. E. Zoller, The Derby Oil Company.

Avgas Committee

Hallanan also appointed a 21-member industry committee to help the military get the aviation gasoline and other products it needs to meet increased requirements. Chairman is Brewster B. Jennings, Socony-Vacuum Oil Company, Inc., with J. Frank Drake, Gulf Oil Corporation, vice chairman. Drake headed a similar NPC group during the 1947-48 shortage period.

Named chairman of a second NPC committee which will study and report to the Interior Department on the industry's shortage capacity for crude oil and products is L. S. Wescoat, The Pure Oil Company.

Members of the military requirements committee include: Hines H. Baker, Humble; T. H. Barton, Lion Oil Company; Jacob Blaustein, American Trading & Production; Reid Brazell, Leonard Refineries, Inc.; Bruce K. Brown; H. S. M. Burns, Shell Oil Company; R. G. Follis, Standard Oil Company of California; B. I. Graves, Tide Water Associated Oil Company; W. T. Holliday, The Standard Oil Company (Ohio); J. P. Jones, National Stripper Well Association; W. Alton Jones, Cities Service Oil Corporation; Harry Leyendecker, Independent Refiners Association of America; R. L. Majewski, Superior; J. Howard Marshall, Ashland Oil & Refining Company; L. F. McCollum, Continental; P. C. Spencer, Sinclair Oil & Refining Company; Reese H. Taylor, Union Oil Company of California; W. W. Vandeveer and R. E. Wilson, Standard of Indiana.

Comprising the storage capacity committee are H. T. Ashton, Western Petroleum Refiners Association; Paul G. Blazer, Ashland; Horace E. Davenport, Independent Oil Men's Association of New England; Charles S. Jones, Richfield Oil Corporation; John M. Lovejoy, Seaboard Oil Company of Delaware; Baird H. Markham, APIC; Rankin P. Peck, National Congress of Petroleum Retailers; M. H. Robineau, Frontier Oil Refining Corporation; Roland V. Rodman, Anderson-Prichard Oil Corporation; Clarendon E. Streeter, Pennsylvania Grade Crude Oil Association; and Vandeveer, Standard of (Indiana).

David Boyd Awarded Chemical Engineer Degree

For his development work on the graphic instrument panel and his paper, "Process Control by Graphic Panel," David M. Boyd, instrument engineer for Universal Oil Products Company, Chicago, was last month awarded the degree of chemical engineer from the University of Colorado. Presently, Boyd is serving chairman of the production processes committe of the Instrument Society of America. He is also a member of the American Institute of Chemical Engineers and the American Chemical Society.

U. S. Rubber Reactivates Port Neches Rubber Plant

United States Rubber Company will begin work immediately to reactivate the GR-S synthetic rubber plant at Port Neches, Texas, as requested by the Reconstruction Finance Corporation. The plant is expected to be in operation in about three months. Equipment which was dismantled and put into standby when the plant was closed after World War II is to be reassembled. The Port Neches plant has a rated capacity of 60,000 tons which could be increased to 75,000 tons.

United States Rubber Company is operating a government-owned synthetic plant at Naugatuck, Conn., with a capacity of 30,000 tons, and also a plant at Borger, Texas, with a capacity of 45,000 tons. The company will continue to operate the Borger plant until Port Neches is fully reactivated, after which operation of Borger will be turned over to the Phillips Chemical Company. All supervisory personnel at Borger will be transferred to Port Neches.

Tulin

McLaren

California Associaiton Elects 1950-51 Officers

Officers of the California Natural Gasoline Association elected last month for 1950-51 include R. S. Tulin, manager of the natural gas and gasoline department, Shell Oil Company, president, succeeding J. B. Taylor, Signal Oil and Gas Company; George C. McLaren, general superitendent of southern district natural gasoline department, Standard Oil Company of California, vice president; and E. R. Millett, Jr., reappointed secretary-treasurer.

Named to the executive committee representing Class A are F. E. Bradley, C.C.M.O. Company; C. L. Case, Continental Oil Company; R. C. Enderly, Wilmington Gasoline Company; W. H. Kraft, Honolulu Oil Company; H. M. Paulsen, The Norwalk Company; E. W. Walker, Western Gulf Oil Company. Class B members are P. E. Foote, Petrolane, Ltd., and Wm. Moeller, Jr., Southern California Gas Company. J. S. Fluor, Jr., of The Fluor Corporation, Ltd., represents Class C.

Jersey Affiliates List Plant Completions for 1951

Refinery and other plant construction of Standard Oil Company (New Jersey) and its affiliates, either planned for completion in 1951 or under construction, include units for the U. S., Canada, Norway, and France, with most of construction taking place in the U. S. and Canada.

Two desalting units each having a rated 45,000-barrel-per-day capacity are planned for Esso Standard Oil Company for Bayway, N. J. Completion is expected in February, 1951.

Esso is also planning to complete at the same time a 55,000-barrel-per-day desalting unit at Baton Rouge, La.

A new refinery of Imperial Oil Limited, in the engineering stages at Winnipeg, Saskatchewan, Can., includes a new cat cracker. The 10,000-barrel-per-day plant is to be operating by May, 1951.

At Regina, Sas., Imperial is planning a 16,000-barrel-per-day desalting unit for completion early in 1951.

Another desalting unit with a capacity of 22,000 barrels per day is to be erected at Edmonton by early 1951.

N.A.M. was to have completed last month rehabilitation to the extent of 1000 barrels per day for the Vallo, Norway, refinery.

For the Port Jerome, France, refinery, Standard Francaises des Petroles plans propane dewaxing and propane deasphalting units, 1200 and 1800 barrels per day, respectiveiy. Estimated completions for both are end of 1951.

Quaker State Buys Titusville Refinery

Quaker State Oil Refining Corporation has bought the 2000-barrel per day Titusville, Pa., refinery of Cities Service Oil Company (Pennsylvania), together with producing properties and pipe line facilities in the northwest section of the state, Cities Service marketing outlets in western Pennsylvania were not included.

Pennzoil Pittsburgh Plant To Belong to Waverly

Waverly Oil Works has agreed to pay approximately $425,000 for the 2500-barrel-per-day Pittsburgh refinery of Pennzoil Company which will use the site as

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
Trends in Week Ended	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1949:									
January 29	5,493	5,490	255,450	17,331	114,677	7,347	63,142	8,178	63,333
February 26	5,601	5,412	261,965	17,621	124,282	7,430	54,008	8,225	59,348
March 26	5,188	5,353	266,506	17,417	129,087	6,167	48,721	8,305	58,792
April 30	4,980	5,273	271,255	17,966	124,787	6,681	49,950	8,185	60,174
May 28	4,951	5,207	275,190	18,324	120,661	5,943	55,971	8,144	63,758
June 25	4,944	5,322	274,114	18,402	115,715	8,148	63,040	7,886	66,146
July 30	4,731	5,187	271,999	18,058	100,964	6,293	70,767	7,206	67,166
August 27	4,769	5,215	266,455	18,180	106,280	6,491	74,718	7,597	64,304
September 24	4,953	5,377	259,190	18,152	103,262	6,585	81,414	7,419	68,143
October 29	5,075	5,569	252,969	18,002	103,915	7,016	90,358	7,754	69,459
November 26	5,192	5,531	256,409	18,304	104,917	6,971	91,795	8,104	67,087
December 24	4,955	5,482	256,880	18,045	110,184	7,335	78,962	8,046	61,647
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,380	57,036
February 25	5,000	5,277	245,586	17,703	133,888	6,980	56,050	7,635	48,963
March 25	4,848	5,400	244,227	17,859	138,408	6,370	40,377	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,955	6,531	36,886	7,272	39,260
May 27	5,118	5,501	240,842	18,704	122,757	7,391	40,607	7,421	30,308
June 24	5,355	5,636	240,762	19,628	115,036	6,868	50,580	7,661	41,291
July 29	5,522	5,870	240,236	19,981	109,076	7,266	61,437	7,870	42,253

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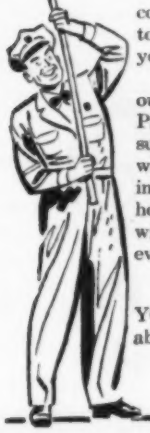

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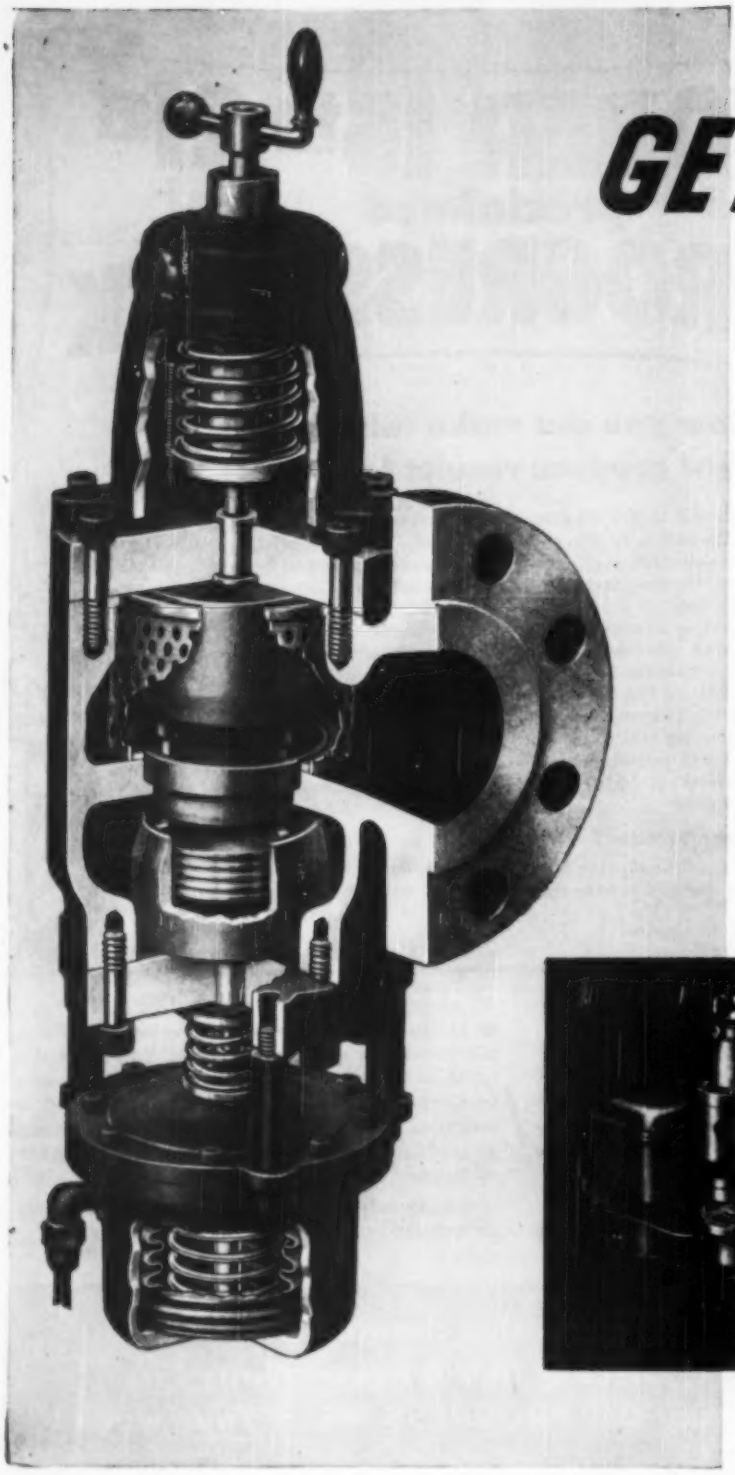

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GE

TYPE
DP

BEST IN VALVING

WITH STANDARD TURBINE DRIVES

On General Electric's standard Type DP mechanical-drive turbine, the trip-throttle valve and the governing valve are combined into one casing. This exclusive G-E feature provides a compact and neat design which simplifies piping by usually eliminating the need for a separate valve in the steam line. You get easier operation, too, because pressures across the valves are equalized. The throttle valve mechanism is ball-bearing mounted, and only hard packings are used.

POSITIVE OVERSPEED PROTECTION

A bolt-type emergency governor, mounted in the turbine shaft, actuates a trip mechanism when speed rises 15% above normal. This action trips the throttle valve closed, positively shuts off steam flow to the turbine. A convenient hand lever is also provided for tripping the valve.

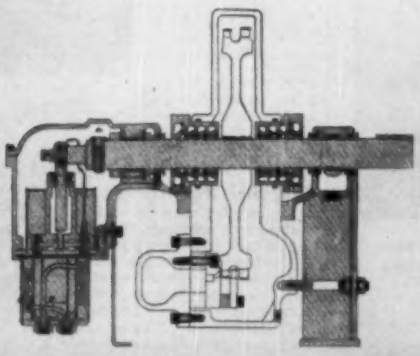
BETTER GOVERNING AND REGULATION

Working with the DP's powerful hydraulic governor, the governing valve gives you greater performance accuracy. The balanced reaction design reduces valve unbalance to a minimum. Relief holes equalize pressure between the valve and the guide piston of the seat. Hard packing decreases the force required to move the valve, results in smoother operation.

LONG LIFE AND DEPENDABILITY

The stainless steel stem and nitrided stainless steel valve and seat are designed to last for years. Maintenance is cut through the use of corrosion-resistant labyrinth stem sealing bushings. No soft packings are used. An easily removable monel steam strainer in the throttle valve chest halts foreign material before it can reach valve or steam parts.

Look into *all* the features of the standard DP turbine. You'll find many extras, such as the valving, which can give you the performance and savings you want from a mechanical-drive turbine. Contact your nearest G-E sales office, or write for bulletin GEA-4955. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*



HOW STANDARDIZATION WORKS FOR YOU

In the diagram at the left, all shaded parts are interchangeable on all sizes of DP turbines. Thus, it is easy to stock spares, and maintenance costs are reduced. All models have standard shaft height and coupling fits for easy installation or re-location in your plant. Standardization cuts manufacturing expense and the savings are passed on to you in the form of extra features, usually found only on "special" turbines.

GENERAL ELECTRIC

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When the problem is moving air or gas, turn to *R-C dual-ability* for accurate, dependable answers

That's one job we know, inside-out. For almost a century, we've been air-and-gas specialists, exclusively. Without being immodest, we think our engineers are the best informed in the industry, on blowers, exhausters, gas pumps and related equipment.

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As to how R-C equipment performs, our old-time, repeat customers are the best answer to that. They'll testify that you will reduce your buying and operating problems when you call on R-C air-and-gas specialists.

ROOTS-CONNERSVILLE BLOWER CORPORATION
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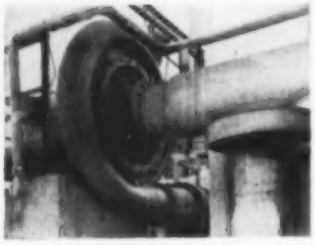
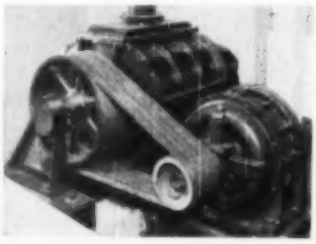
CENTRIFUGAL

Type OI, Single-stage Centrifugal Blower for outdoor operation at oil refinery. Capacity 11,750 cfm.





ROTARY

R-C Rotary Positive Blower used in oil processing. Capacity 3,160 cfm.

ROOTS-CONNERSVILLE BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

The MONTH...

bulk plant and terminal, unless the world situation calls for continued operation. Waverly will run the refinery until October 1, continuing to sell industrial oil and greases and produce and sell crude oil. The extent of its marketing activity and personnel changes as a result of sale depend upon details to be worked out with Pennzoil.

Pennzoil had been shipping products from its Oil City, Pa., refinery through the Waverly plant down the Ohio, and now plans increased storage at the plant.

Sinclair Buys Refinery Of Wood River at Hartford

Sinclair Refining Company has acquired the 30,000-barrel-per-day refinery of Wood River Oil & Refining Company at Harford, Ill. Also purchased was Wood River's 67-mile petroleum products pipe line.

Located on a 431-acre tract about 15 miles north of St. Louis, the modern plant refines crude into gasoline, diesel fuel, asphalt road oil, fuel oil, and other petroleum distillates. It has also been processing quantities of crude into products for Sinclair. The pipe line extends from a marketing terminal at Peru, Ill., on the Illinois River, to another marketing terminal at Rockford, Ill.

The Wood River acquisition brings Sinclair's major refineries to seven, of which four—those at Houston, Wood River, East Chicago, Ind., and Marcus Hook, Pa.—are interconnected by pipe line and water transportation.

General Superintendent At Wood River Refinery

Michael H. Nolan has been appointed general superintendent of Sinclair Refining Company's newly acquired refinery at Wood River, Ill. Prior to joining the Sinclair organization in 1934, Nolan was with Producers and Refiners Corporation, a subsidiary of Prairie Oil and Gas Company, at Tulsa, as assistant superintendent of the refinery there. Since with Sinclair, he has also been superintendent of the Sinclair, Wyo., refinery.

Nolan

Taylor Refining Acquires Coastal Refineries Plant

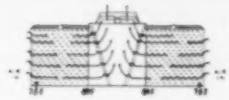
Taylor Refining Company at Taylor, Texas, has acquired all assets and assumed all liabilities of Coastal Refineries, Inc., including a 6000-barrel-per-day refinery at Port Isabel, Texas, and all oil and gas producing properties. The cycling plant near McAllen, Texas, will be operated by Taylor and will be known as the Taylor-Mayfair cycling plant. Taylor Refining said there will be a change in management or in operating personnel as a result of corporate changes.

Safety Director Promoted

Jenry W. Jouette, former safety director for Magnolia Petroleum Com-

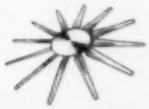
OPEN DISTRIBUTION SYSTEM

Double-Flows always operate at top efficiency because the water distribution system is available. Water flow to each cell is easily regulated . . . cleaning, a matter of minutes.



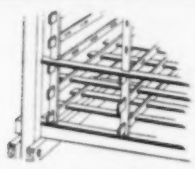
COLDER WATER

Water falling near the louvered side walls is at near wet bulb temperature. Only Double-Flow, with its cross-flow design, can give this extra-cold water.



MULTIBLADED FANS

Vibration and "rough operation" caused by air pulsations are prevented by the use of multibladed fans. These large rugged, multibladed fans insure longer tower life.



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NO AIR CHANNELING

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Marley research and development is continually at work bringing out new ideas—setting a higher standard for the cooling tower industry.

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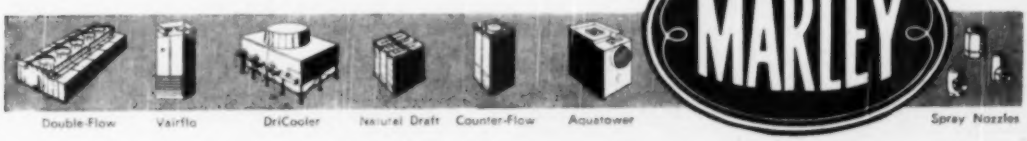

The MONTH...

pany's refining division, has been promoted to mechanical superintendent in charge of maintenance activities at the company's Beaumont, Texas, refinery. He is replaced by Parker C. Folse, who has been assistant safety director.

Jouette joined Magnolia in 1918.

Cities Service Manager Of Refining To Retire

H. W. (Hi) Camp, manager of the refining division of Cities Service Oil Company (Delaware), will retire September 1 after 33 years with the company. Camp, who is also a member of the board, started with the company in 1917, when Cities Service was acquiring a number of refineries to take care of the oil from its newly discovered Eldorado, Kan., field.

Camp

He is a nationally recognized authority on refinery construction and operation and during World War II served on several important war committees.

Synthetic Fuels Processes Studied for Chemicals

Current shortages and increasing requirements for benzene and phenol have induced the Bureau of Mines to undertake an investigation of these and other chemicals available in producing synthetic liquid fuels from coal and oil shale, according to Director James Boyd. Consultants appointed to assist in a general study of processes, yields, and markets are Dr. Gaston Du Bois of St. Louis, Mo., formerly with Monsanto Chemical Company, and L. A. Schlueter of Washington, D. C., who is associated with the American Coke and Coal Chemicals Institute.

Major objective of the study, in which the National Security Resources Board has expressed interest, is to determine the most desirable processes for producing chemicals in conjunction with synthetic fuels. Potential benefits would include a new source of short-supply chemicals; a supplementary source of aromatics or other special fuel components required by the armed forces; and reduction of the cost of synthetic liquid fuels by the co-production and sale of chemical.

Cities Service Director Gets Armour Institute Post

Dr. Rolston L. Bond, technical director of the butadiene division of Cities Service Refining Corporation, Lake Charles, La., has been named assistant chairman of the chemistry and chemical engineering department at Armour Research Foundation of Illinois Institute of Technology. Dr. Bond will be in charge of the foundation's biochemistry and organic chemistry research activities.

Dr. Bond has been with Cities Service since 1943. He was a research chemist for Tidewater Oil Company and National Oil Products Company from 1938 to 1943. Dr. Bond received his Ph. D. degree from Pennsylvania State College in 1940.

OWIU-Texaco Truce Ends Port Arthur Plant Strike

The Texas Company, Oil Workers International Union (CIO), and Local No. 23 agreed to a 60-day truce at Texaco's 190,000 barrel per day Port Arthur, Texas, refinery. The July 29 agreement, which is similar to that at the Port Neches, Texas, plant, ended the 5-month old dispute which began April 4. Wages, hours, and working conditions in effect at the plant unit at time strike began are to be in effect until a new labor contract is executed or until terminated by 60 days' prior written notice by the company to Local 23, OWIU, whichever occurs sooner.

Joint Districts of LPGA Schedule October Meet

Plans for a joint meeting of the northeastern and southeastern districts of the Liquefied Petroleum Gas Association to be held in Atlantic City, N. J., October 5, include speeches on recent developments in connection with LPG weights and measures, on the national LPG promotional program, and on distribution costs. A skit dramatizing the technique of closing an LPG range sale is also planned.

Anniversary Meet Set

The silver anniversary of the California Natural Gasoline Association will be observed at a meeting November 9-10 in Los Angeles. M. L. Arnold of Richfield Oil Corporation has been appointed fall meeting chairman.

THE OIL MAN'S CALENDAR

1950	
AUG.	
14–16	Society of Automotive Engineers, West Coast Meeting, Los Angeles, Biltmore Hotel.
SEPT.	
5– 8	American Chemical Society, Chicago.
5– 9	American Chemical Society, 6th National Chemical Exposition by Chicago Section, Chicago, Coliseum.
11–15	American Society of Mechanical Engineers, Industrial Instruments and Regulators Conference with the Instrument Society of America, Buffalo, N. Y., Municipal Auditorium.
13–15	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
18–22	Instrument Society of America, Fifth National Conference and Exhibit, Buffalo, N.Y., Memorial Auditorium.
25–27	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Division, New Orleans, The Roosevelt.
OCT.	
1– 3	Independent Petroleum Assn. of America, Annual Meeting, St. Louis.
3– 6	American Gas Association Annual Convention, Atlantic City, N.J.
16–20	National Safety Congress, National Safety Council Exposition, Chicago.
16–21	Oil Progress Week.
17	Natural Gasoline Association of America, Southern Regional Meeting, Tyler, Texas, Blackstone Hotel.
30 to Nov. 1	National Lubricating Grease Institute, Annual Meeting, Chicago, Edgewater Beach Hotel.
1950	
NOV.	
2– 3	Eighth Annual Pittsburgh Conference on X-Ray and Electron Diffraction, Pittsburgh, Mellon Institute for Industrial Research.
2– 3	Society of Automotive Engineers, Diesel Engine Meeting, Chicago, Hotel Knickerbocker.
9–10	Society of Automotive Engineers, Fuels and Lubricants Meeting, Tulsa, The Mayo.
10	California Natural Gasoline Association, 25th Annual Fall Meeting, Los Angeles, Ambassador Hotel.
11–13	Oil Industry Information Committee, Los Angeles, Biltmore Hotel.
13–16	American Petroleum Institute, 30th Annual Meeting, Los Angeles, Biltmore Hotel and Ambassador Hotel.
26 to Dec. 1	American Society of Mechanical Engineers, New York, Hotel Statler.
27 to Dec. 2	American Society of Mechanical Engineers, 10th Exposition of Power and Mechanical Engineering, New York, Grand Central Palace.
DEC.	
3– 6	American Institute of Chemical Engineers, Annual Meeting, Columbus, Ohio, Neil House.
1951	
April	
16–18	American Society of Lubrication Engineers, Annual Convention and Lubrication Show, Philadelphia, Bellevue-Stratford Hotel.
18–20	National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.
30 to May 3	American Petroleum Institute, Division of Refining, Midyear Meeting, Tulsa.

Case Institute Schedules Corrosion Short Course

Nine lecture periods have been programmed for the Case Institute of Technology corrosion short course to be held September 25-29 at Cleveland, Ohio.

Authorities in corrosion and corrosion prevention who have accepted are F. L. LaQue, The International Nickel Company, Inc., New York; Dr. R. B. Mears, Carnegie-Illinois Steel Corporation, Pittsburgh; H. A. Robinson, Dow Chemical Company, Midland, Mich.; Professor Mars G. Fontana, Ohio State University, Columbus, Ohio, and Professors W. von Fischer, E. G. Bobalek and R. B. Hoxeng of Case Institute.

The Case Institute course is the second such undertaking in which NACE has cooperated, the first being at the University of Texas, Austin, in September, 1949.

Tentative program includes corrosion fundamentals; pertinent fundamentals of metallurgy; types of corrosion and choice of materials; use of inhibitors and chemical treatment; electrolysis and cathodic protection; protective coatings, fundamentals and application; and designing to prevent corrosion.

Survey Estimates Gas Firms Construction for Future

Gas companies plan to spend $1066 million for new construction this year, and $3135 million from 1950 through 1954, according to an industry survey prepared by the American Gas Association and based on information furnished by gas utility companies who account for 90 percent of the industry's revenues. Of the scheduled expansion in the next five years, the natural gas branch of the gas industry will account for the big-

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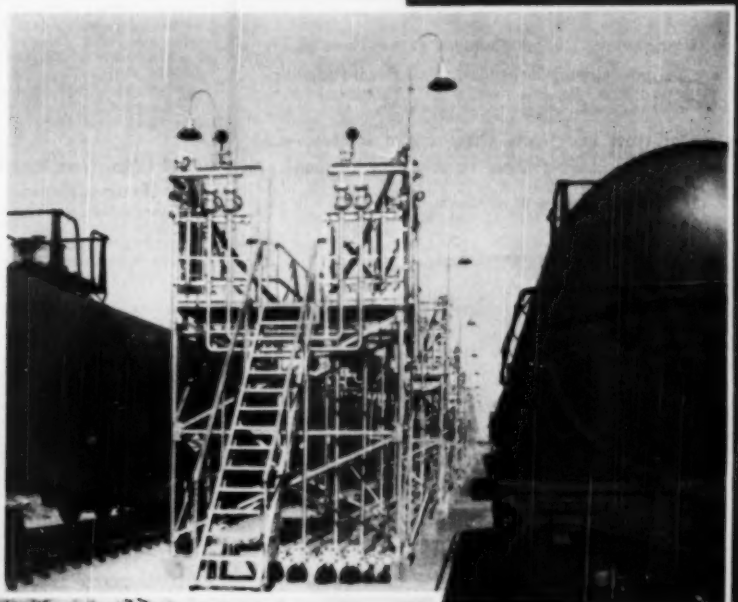

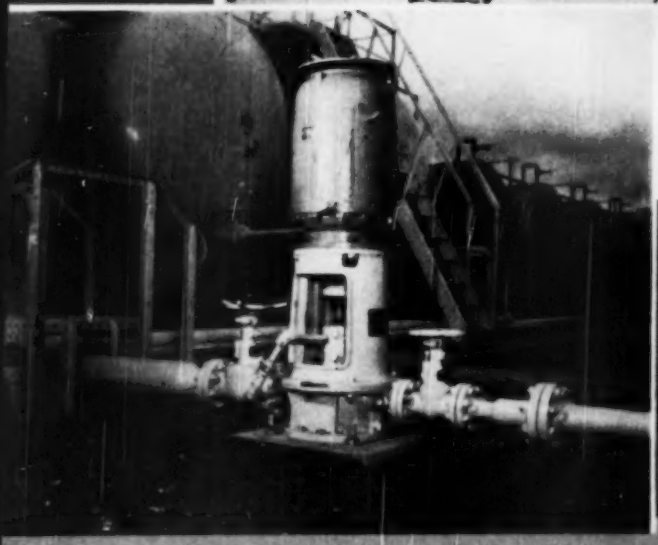

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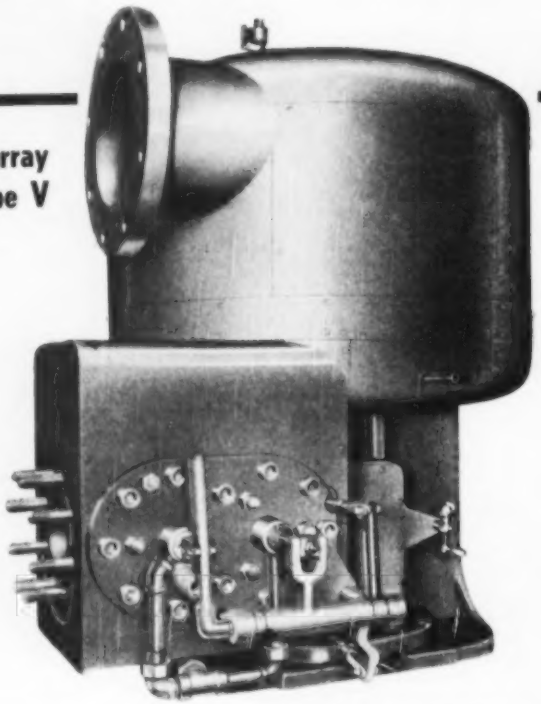

Among the newest in the Murray turbine line is the Type V vertical turbine, above. This machine provides completely enclosed construction, either direct-connected or geared for vertical pumps up to 600 HP and beyond. See that your new vertical pump is driven with a Type V steam turbine.

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The MONTH...

gest slice, approximately $2750 million. The remainder represents construction planned by manufactured, mixed and "bottled gas" utility companies.

If construction expenditures for 1950 meet expectations, it will mark the first time in the industry's history that more than $1 billion has been spent in a single year for new equipment and facilities.

An estimated $1110 million of the 1950-1954 program will go for new distribution facilities; 80 percent will be spent by natural gas companies. Another $426 million will go for production and gas storage facilities, including the development of new underground natural gas storage fields.

GM Changes Requirements For Transmission Fluid

General Motors Corporation announces changes in its automatic transmission, incorporating mechanical viscosity index numbers in the unit, making it possible to effect a reduction in chemical viscosity index numbers required in automatic transmission fluid type A. Changes in requirements for the fluid are such that products superior to present production fluids will not be required, though they will be acceptable, according to General Motors. No changes have been made in oxidation resistance, oiliness or anti-squawk and other properties or in Armour qualification procedure as outlined in May, 1949.

Copies of the new fluid requirements can be obtained from H. R. Wolf, assistant to the technical director, Research Laboratories Division, General Motors Corporation, Detroit.

Southern Production Buys Control of Danciger

Southern Production Company of Shreveport, La., has acquired the controlling interest of Danciger Oil and Refining Company of Fort Worth for about $27.7 million. Southern had purchased 1,107,076 shares of the stock at a price of $25 a share, representing 68 percent of the stock. An offer will be made to all of the minority stockholders to buy their stock at the same price, according to C. T. Chenery, chairman of the Southern Production board.

Members of the Danciger family will retire from the business, but other officers will be retained.

In addition to considerable oil holdings, Danciger owns with Humble Oil & Refining Company a half interest in a large Gulf Coast gas field with reserves estimated at 1.25 to 1.5 trillion cubic feet.

Procon, Inc., New Firm, to Handle UOP Platforming

A new subsidiary of Universal Oil Products Company is Procon, Incorporated, which has been organized to handle the construction of refinery specialty installations, particularly units for operating UOP's Platforming process.

New officers are I. C. Raaen, president; G. B. Whyte, vice president and general manager; and C. J. Giuliani, secretary and treasurer. Colonel Raaen was, before his retirement from the Army in 1947, commanding officer of Watervliet

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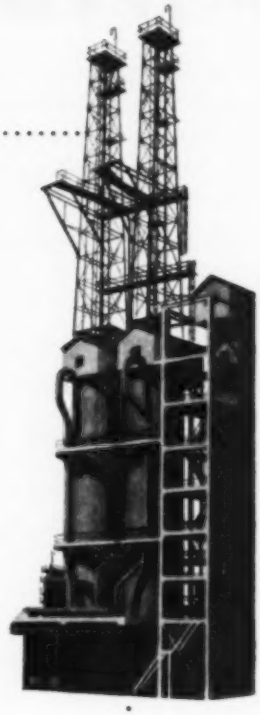

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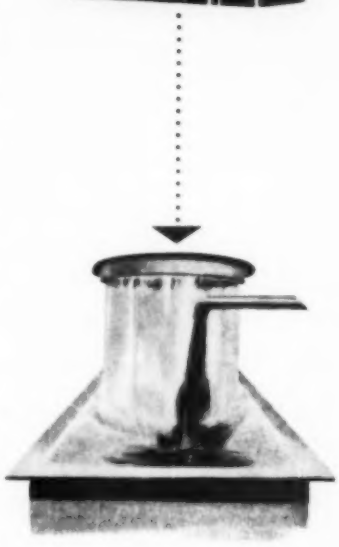
Here is an example of how the coordinated ingenuity of designer, engineer, fabricator and materials supplier enabled a refinery to improve the efficiency of its plant and the quality of its products. This was the result of applied *Lukenomics*. For Lukenomics combines the experience of equipment designers and builders with Lukens' knowledge of materials and their application gained over 140 years as the world's leading producer of specialty steel plates and heads and steel plate shapes.

It's sound judgment to put Lukenomics to work on your equipment problems. There are progressive fabricators who can do this for you. Get in touch with them, or write our Manager of Marketing Service, stating your problem. Lukens Steel Company, 404 Lukens Building, Coatesville, Pennsylvania.



The entire East Chicago refinery of Cities Service Company was modernized and made a fully integrated plant by the M. W. Kellogg Company which designed, engineered and constructed the delayed coking unit shown above. Lukens Stainless-Clad Steel, Type 405, was used for the coking drums, which were fabricated by Chicago Bridge & Iron Company, at its Birmingham, Ala. plant.

LUKENS

LUKENS STEEL COMPANY

BETTER PRODUCTS FOR BETTER EQUIPMENT

The MONTH...

Arsenal. Field operations will be under the direction of Whyte who has been with UOP since 1946 supervising the construction of processing units in foreign and domestic refineries. His function now will be to contract for and build refinery processing facilities. Whyte has also been chief engineer of the refinery division of Arkansas Fuel Oil Company and was construction supervisor for Cities Service Oil Corporation's government Maumuelle Ordnance Works at Little Rock, Ark. and the Lake Charles, La., refinery.

Oil Research Authority Retires from Phillips

G. G. Oberfell, vice president of research and development for Phillips Petroleum Company has retired after nearly 26 years of service with the company. Oberfell, a nationally recognized authority on petroleum research, established the research and development department for Phillips after joining the company in 1925.

Oberfell

He is also a director and member of the executive committee of the company, a vice president and director of Phillips Chemical Company, vice president of Phillips Terminal Company, the latter two being wholly-owned subsidiaries of Phillips Petroleum Company.

Company changes include B. F. Stradley, secretary and treasurer for several years, becomes member of the board and executive committee, vice president, and treasurer; R. W. Thomas, manager of the research and development department, is vice president of research and development, supervising research and patent activities as well as chemical manufacturing, development, and sales; and Paul J. Parker assistant secretary and assistant treasurer is now secretary and assistant treasurer.

Texaco Expands Fellowships

The Texas Company has established new fellowships at the University of Cincinnati and New York University, expanding the Texaco program which supports 18 fellowships and grants in institutions. The fellowship and research grants cover subjects from nuclear research to textile lubrication and microchemical research techniques.

API Refining Meet Set

The 1951 midyear meetings of the Division of Refining of the American Petroleum Institute will be held in Tulsa, April 30-May 3, it was announced last month.

Sterling Pact Made for Caltex Bahrein Products

Products refined by Caltex at Bahrein from both its own (Bahrein) and Aramco crude are to be distributed on an equal footing with sterling oil throughout the sterling area by a British affiliate, Cal-

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This all adds up to a lot of adsorbent experience—experience with the many treatments which precede the application of these two basic materials to specific adsorbent jobs; and experience measured by our extensive research and product evaluation—from laboratory and pilot plant on through to commercial scale phases—both on our own and in cooperation with our customers.

So there's great merit to the suggestion that it pays to consult Attapulgus and Porocel. In your own plans to improve products or expand output, perhaps our one billion barrels of adsorbent experience can be of real help to you in selecting the right adsorbent and the right conditions. Our laboratory and process staff are at your service, without obligation.

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tex (U. K.) Ltd. Not affected by the agreement are the Aramco crude Caltex offtakes at Ras Tanura and sells or the products Caltex lifts at Ras Tanura.

One of the effects of the arrangement is to put Caltex's tanker freighting in that distribution on a sterling basis. The company is having seven tankers built in British yards, will order two more, and all will be used in the sterling area.

Du Pont Survey Shows Octane Number Trends Up

July figures for eight principal U. S. cities indicate steadily higher trends in research octane numbers. Included in the July gasoline motor survey made by E. I. du Pont de Nemours & Company, Inc., are Philadelphia, Houston, Tulsa, Chicago, San Francisco, Denver, Detroit, and Los Angeles. Arithmetic averages by city were obtained from this survey and previous ones.

Philadelphia showed the highest July rating with an ASTM octane number of a fraction over 92 for premium and 87 for regular gasolines. Houston was next with 92 premium and almost 86 regular. In June, 1948, Philadelphia had 87 premium and 84 regular, while Houston rated almost 87 premium and slightly over 82 for regular. Chicago showed the most marked advance in premium gasoline over the two-year period with 83 for June, 1948, and 89 for last month. Slightest variance shown was by Los Angeles which had 89 premium in June, 1948, and almost 91 during last month.

Richardson Refinery To Be Opened by September 1

Repairs have been started on Sid Richardson Gasoline Company's Texas City, Texas, refinery with the aim of running the plant to 10,000 barrels per day by September 1. Present plans for reopening are still not definite, according to Freeman Burford, president of the plant.

The plant, which formerly had a capacity of 25,000 barrels per day, has been idle for approximately 15 months.

Navy Admiral Assistant To Socony Board Chairman

Rear Admiral Thomas J. Kelly, U. S. Navy (Retired), has joined Socony-Vacuum Oil Company, Inc., as an assistant to the chairman of the board. Admiral Kelly was with the Navy 33 years.

Admiral Kelly was raised in the mid-continent oil country, where in his early youth he worked as a roustabout in the oil fields. A graduate of the U. S. Naval Academy in 1920, he is also a graduate petroleum engineer from the University of Pittsburgh.

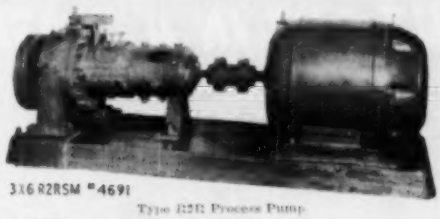
Socony Paulsboro Refinery Announces Staff Changes

Four promotions and a retirement at its refinery in Paulsboro, N. J., have been announced by Socony-Vacuum Oil Company, Inc.

E. L. Sinclair, a University of Michigan graduate who started with the company in 1938, became assistant to R. R. Jackson, manager of the refinery. He

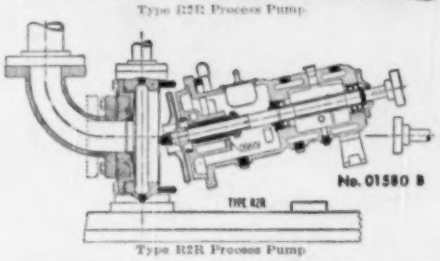
DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



3X6 R2RSM "4691

Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute.
Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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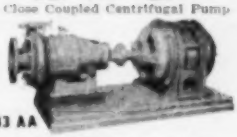
CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

3510

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

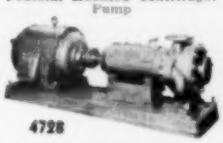


4043 AA

Pedestal Mounted Centrifugal Pump

3833

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



4728

Double Pedestal Bearing Centrifugal Pump

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Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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with rate-of-rise thermostats are always ready for instant action. At the first indication of dangerous temperatures they sound an alarm and start a dense, quenching fog of water to the "hot spot." Rapid dissipation of heat prevents the development of high temperatures, possible bursting pressures, and confines the damage to a small area.

A Blaw-Knox Engineer will make a survey of your fire hazards, secure your insurance underwriter's requirements, prepare a preliminary layout of a system that will give you the utmost in fire protection, and submit an estimate of costs—all without obligation.

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Offices in Principal Cities

BLAW-KNOX FIRE PROTECTION SYSTEMS

The MONTH...

was transferred to Paulsboro in 1949.

R. M. Chesney, graduate of the University of Delaware, was appointed operating superintendent. He started with Socony-Vacuum in 1932.

T. C. Lockhart succeeded Chesney as assistant operating superintendent. He is a graduate of the Drexel Institute of Technology and started with Socony-Vacuum in 1936.

J. L. Lawrence, graduate of the University of California who joined Socony-Vacuum at the Paulsboro refinery in 1946 as assistant chief engineer, moved up to chief engineer to succeed E. H. Atwood, retired, after 38 years of Socony-Vacuum service.

New Gulf Lube Oils Used For Precision Instruments

Two new "synthetically tailored" lubricants, recommended for use in virtually all fine precision instruments, are being introduced by the Gulf Oil Companies. The lubricants, Gulf special instrument oil and Gulf micro bearing oil, are the result of years of research by Elgin National Watch Company working in collaboration with the Gulf Research Fellowship at Mellon Institute of Industrial Research in Pittsburgh. Both oils are manufactured by Gulf Research & Development Company at Harmarville, Pa.

In addition to non-spreading tendencies, the oils are highly resistant to oxidation and are exceptionally low in volatility, thus permitting their use over prolonged periods with a minimum of gumming or thickening.

Becomes Superintendent Sun Starr County Plant

H. O. Evinger has been named superintendent of Sun Oil Company's Sun Field natural gasoline plant in Starr County, Texas. He formerly was superintendent of the Jameson natural gasoline plant in Coke County, Texas, and is succeeded there by John Shimer.

Roy L. Cochran, formerly superintendent of the Sun Field plant, has been transferred to Brookhaven, Miss., for a special assignment.

Du Pont Releases Patents

E. I. du Pont de Nemours & Company, Inc. has released 32 patents for royalty-free use by government and private parties. Included are patents covering treatment of metals, refining liquid hydrocarbons, preparation of high molecular weight alcohols, lead refining, metallic sodium dispersions, and coating of metals.

Description of each patent is available from U. S. Patent Office, Washington 25, D. C. at 25 cents a copy.

1951 WPRA in San Antonio

Western Petroleum Refiners Association will hold its 1951 annual meeting in San Antonio, for three days starting April 1.

Joins Hinchman Firm

E. R. Shepard has joined The Hinchman Corporation of Detroit as technical associate. Shepard was recently with the Corps of Engineers, Washington, D. C.

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Debutanizer Reflux Accumulators
Visbreaker Gasoline Accumulator
Naphtha Feed Accumulator
De-emulsifiers
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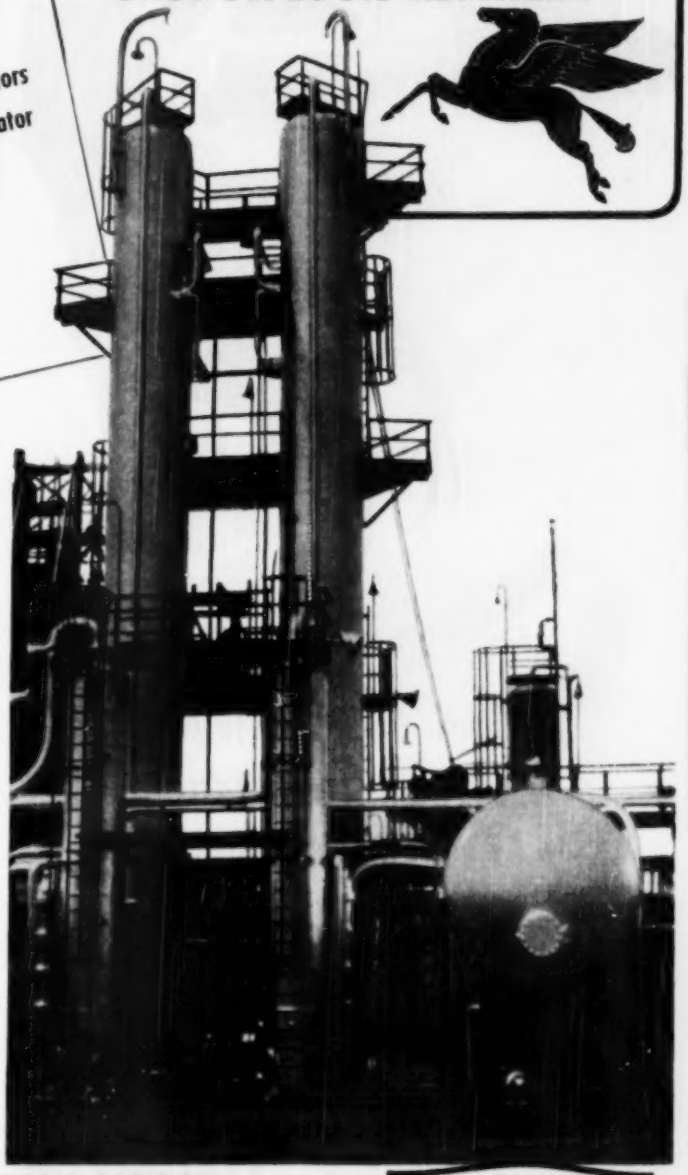

■ Graver congratulates Socony-Vacuum on the completion of its modernization program at the East St. Louis refinery.

This modernization involves expansion of crude distillation facilities, revamping and expansion of thermal cracking and delayed coking operations, and a gasoline treating unit. The total refinery capacity rating will be increased about 10,000 b/d to 30,000 b/d, resulting in increased production of gasoline, kerosene and distillate fuel oils.

Graver-built equipment at this refinery performs an important role in the expansion of Socony-Vacuum service to its customers.

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Santa Fe

The MONTH...

and the National Bureau of Standards in the fields of soil corrosion and cathodic protection and geophysics. He holds an electrical engineering degree from the University of California and a master of arts degree in physics from Harvard University.

Bureau Reports U. S. Runs 62 Percent of World Total

Crude runs to stills averaged approximately 9.2 million barrels per day, the North American average crude runs of 5.8 barrels per day accounting for more than 62 percent of world total, according to the Bureau of Mines first annual summary or world petroleum statistics.

In South America, including the Caribbean islands, crude thruput was 1.1 million barrels per day of which the Netherlands Antilles ran 696,000 barrels per day. In Europe, the largest refiner was France, with a crude intake of 231,000 barrels per day, followed by the United Kingdom with 121,000 barrels per day, and Italy and Trieste 61,000 barrels per day.

Available figures indicate that increases in stocks of crude petroleum of 7000 barrels per day each in Western Europe and the Middle East were offset by decreases of 13,000 barrels per day in North America and 2000 barrels per day in South America, including the Caribbean Islands.

Production of major refined products (excluding USSR and Eastern Europe) average approximately 8 million barrels per day. Output by product was as follows, in barrels per day: motor fuel 3.4 million; kerosine 478,000; distillate fuel oil 1.4 million; residual fuel oil 2.6 million; and lubricating oil 154,000. Percentage yields of heavy fuel oils in most foreign areas was significantly higher than in the U. S., and those of gasoline and other highly refined products, correspondingly lower.

Corrosion Men to Hold 3-Day School in Shreveport

The Shreveport Section of National Association of Corrosion Engineers, has scheduled a three-day corrosion school September 13-15 at Shreveport, La., aimed at familiarizing field men with the nature of and means of controlling corrosion through discussions and demonstrations.

Pat Miller of Texas Eastern Transmission Company is chairman.

Phillips Develops New Carbon Black for Rubber

A new carbon black just developed by Phillips Petroleum Company research and produced on a semi-commercial scale promises to give increased wear resistance to rubber and add more miles to tire life than obtainable from any available carbon black.

The new carbon black when used with "cold" rubber is expected to produce tire treads having 25 to 50 percent better wear resistance than similar treads compounded with the best commercially available carbon black.

The new carbon black, called SAF black, is produced from oil by a continuous process. Although cost per pound probably will be somewhat higher

The MONTH...

than that of the abrasion resistant blacks now on the market, cost per mile of tire life promises to be lower, officials declared.

Instrument Society Conducts Fall Maintenance Clinic

The Instrument Society of America pre-conference instrument maintenance clinic, which was held for the first time last year, will be held again on the three days immediately preceding the opening of the fifth national instrument conference and exhibit on September 18, in Buffalo, N. Y.

The conference, to be held September 18-22, will include the American Institute of Physics, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the Scientific Apparatus Makers Association.

Dow Freeport Expansion To Go Up During 1951

The Dow Chemical Company's $30 million chemical expansion project in the engineering stages at Freeport, Texas, is estimated to be completed by the end of 1951. Engineering is by Dow, with construction by J. F. Pritchard Company, Tellepsen Construction Company, Austin Company, and Stone & Webster Engineering Company.

Jackson Replaces Heath Eves

Basil R. Jackson, representative of Anglo-Iranian Oil Company, Ltd. in U. S. until last December 1, is Anglo-Iranian's deputy chairman. In London, he replaces Sir H. B. Heath Eves, resigned as deputy chairman and managing director, but continuing on the company's board.

Blaw-Knox Appoints

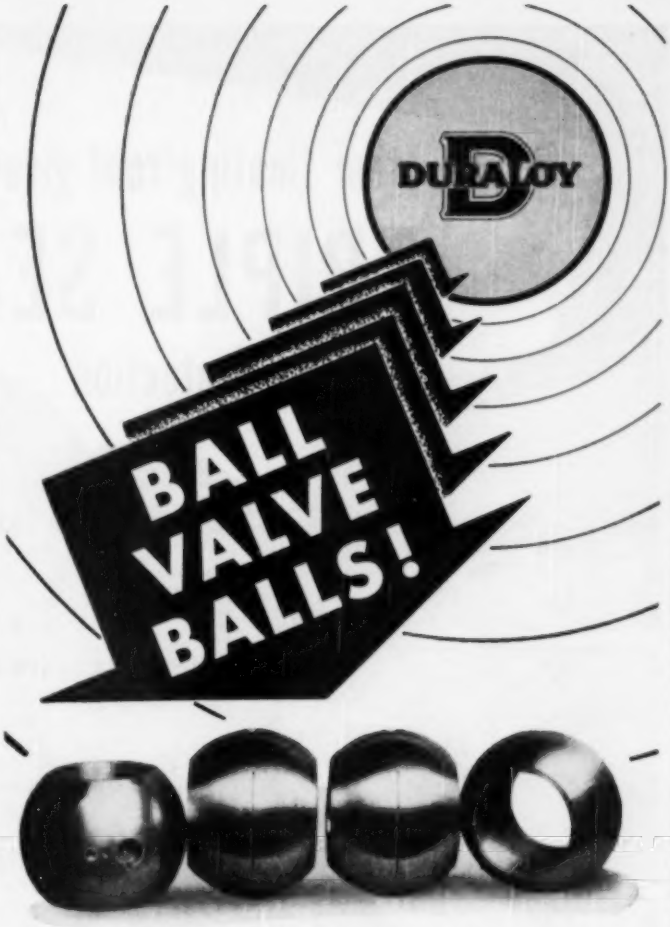
Chemical Plants Division of Blaw-Knox Construction Company has appointed Dr. H. Roswell Jones to its synthetic fuels and chemicals department. Dr. Jones will be engaged mainly in the design of plants to produce finished refined products from Fischer-Tropsch, Oxo, and Oxyl syntheses.

Vice President Dies

Herbert E. Hollberg, 51, vice president, %Proportioneers, Inc.%, Providence, R. I., died July 1 at his home in Cranston, R. I. A native of Sweden and a graduate electrical engineer of the University of Sweden, Hollberg came to this country at the end of World War I. He joined %Proportioneers% in 1933. Since then he had served as the firm's European representative to Sweden, export manager, and vice president. At the time of his death Hollberg was in charge of the sanitary division.

Dr. Otto A. Beeck Dies

Dr. Otto A. Beeck, an associate director of research at Shell Development Company, Emeryville, Calif., died suddenly July 5. Dr. Beeck, who was born in Stettin, Germany, joined Shell Development as a research physicist in 1933, later serving as head of the physics department and associate director.



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Producing chrome-iron, chrome-nickel and nickel-chrome static castings has been our business exclusively since 1922. We helped pioneer this phase of the high alloy casting business just as we helped pioneer centrifugal castings beginning in 1931.

At Scottdale, we have one of the most modern high alloy foundries in the country. We have exceptional technical controls and a 400,000 volt X-ray machine. We can produce individual static castings up to 7½ tons in weight and machine or otherwise finish them to specifications.

In short, we have a broad reliable service in connection with high alloy castings.

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Fundamental Physical and Chemical Data

Thermodynamic Properties of n-Heptane. Edward B. Stuart, Kuo Tsung Yu, and James Coull. *Chem. Eng. Progress*, **46** (1950), pp. 311-2.

Modern developments in the synthesis and recovery of hydrocarbons from basic materials over wide ranges of temperature and pressure have created a need for thermodynamic charts of the higher molecular weight compounds. The authors present the thermodynamic properties of n-heptane as calculated from P-V-T data in the form of a pressure-enthalpy diagram and also in tabular form. The range of conditions covered was from 1 to 300 atmospheres and from 209.08 to 1800° F. A bibliography of 16 references is included.

Carbon Vapor Pressure and Heat of Vaporization. A. L. Marshall and F. J. Norton. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 2166-71.

Vapor pressure values were computed from the measured sublimation rates by use of the Langmuir equation with the accommodation coefficient taken as one. Agreement of the vapor pressures so derived with those published in the literature justifies this choice of accommodation coefficient. From the data, the heat of evaporation of carbon was calculated and found to be 175.2 kcal. per mole. This is in agreement with recent experimental determinations and with the spectroscopic theoretical value of 170 kcal.

Infrared Absorption Band of n-Butyl Group. Stephen E. Wiberley and Lewis G. Bassett. *Analytical Chem.*, **22** (1950), pp. 841-2.

In running a series of infrared spectra of ethers it was noted that all containing an n-butyl group showed a strong absorption band at 7.39 cm.$^{-1}$ Eighteen organic compounds of varying types, all containing one or more n-butyl groups, were measured over the region 720 to 750 cm.$^{-1}$ Also, measurements were taken on compounds not containing the n-butyl group. The authors conclude that the data presents strong evidence that an absorption band in the region 734 to 742 cm.$^{-1}$ is indicative of the presence of the n-butyl group.

Pure Hydrocarbons from Petroleum. John Griswold, Ju-Nam Chew and M. E. Klecka. *Ind. Eng. Chem.*, **42** (1950), pp. 1246-51.

The conjugate liquid-phase equilibria for the hydrocarbons, n-heptane, methylcyclohexane, and benzene with aniline and water at 25° and 50° C. are presented. The n-heptane system and the methylcyclohexane system are characterized by three conjugate phases at both temperatures studied, although methylcyclohexane and water-free aniline are miscible at 50° C. In the benzene system, separate hydrocarbon and aniline phases do not appear at either temperature. Data can be used in connection with the design of counterflow extraction to recover aniline by water scrubbing, or to extract aniline from aqueous solutions by means of a hydrocarbon wash. The data are presented in some detail in tabular and graphical form.

The Magneto-Optical Rotation of Pure Hydrocarbons. J. B. Westerdijk, H. I. Waterman, H. F. O. Span, H. Booy and K. van Nes. *Jour. Inst. of Petroleum*, **36** (1950), pp. 281-91.

The results of the measurements of the Faraday-effect of pure hydrocarbons by Foehr and the authors is discussed. As might be expected from theory, different structural groups of a molecule contribute additively to a constant D, which is a function of the measured Verdet-constant and other physical properties of the substance. This additivity, however, does not hold for contributions of irregular ramifications. This means that the constant D cannot be safely used in structural group analysis if one is especially interested in the number of side-chains of the average molecule in a mixture of hydrocarbons. In this case, however, the Verdet-constant itself may give useful information, which is illustrated by the alkanes with side-chains. The constant D is a linear square of the frequency of the light source if this frequency is sufficiently far removed from the range where absorption occurs. The authors believe that measurements of the magneto-optical rotation may in the future be regarded as belonging to the useful methods of determining the structure of the average molecule in hydrocarbon mixtures, especially in the range of low molecular weight.

Refractivity and Molecular Structure. III. Isomeric Propyl and Butyl Mercaptans. Simao Mathias. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1897-1902.

The densities and refractive indices, at 25° C. for 11 spectral lines, of highly purified samples of isomeric propyl and butyl mercaptans were determined. From the data so obtained, the molar refractivities, dispersivities and volumes were calculated. An attempt was made to correlate these data, and those for analogous isomeric halides, as well as dipole moments and Raman frequencies, from the point of view of the quanticule theory of molecular structure.

These abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles will be supplied at cost by The Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also will be prepared and furnished by arrangement with the Laboratories.

Chemical Composition and Reactions

Kinetics in Tubular Flow Reactor—Hydrogenation of Ethylene over Copper-Magnesia Catalyst. Raymond Wynkoop and Richard H. Wilhelm. *Chem. Eng. Progress*, **46** (1950), pp. 300-10.

The hydrogenation of ethylene over a copper-magnesia catalyst was studied experimentally and theoretically as a typical example of the application of chemical kinetics to a continuous flow tubular reactor. Most experiments were conducted at constant temperature, but in a few the temperature varied slightly. The hydrogen concentration ranged from 32.6 to 95.2 percent; temperature: 9° to 79° C.; space velocity: 0.20×10^{-4} to 32.0×10^{-4} total moles/(cc.)(sec.); catalyst particle size: 0.108 to 0.279 cm. diameter. The kinetic equations for the flow system were developed and it was found that the data indicated a first order reaction with respect to hydrogen. The effect of temperature is expressed by the Arrhenius equation as $k'' = 5960e^{-9,000/RT}$. Because of the small conversions and consequent small change in hydrogen concentrations a method for the high-precision analysis for hydrogen by means of thermal conductivity cells was developed and used. The effect of water vapor in reversibly poisoning the catalyst was observed. Flow equations are discussed and the precautions that must be used in their development are considered. A mechanism for the reaction is proposed.

Polymerization of Thiophene and Alkylthiophenes. Seymour L. Meisel, George C. Johnson and Howard D. Hartough. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 1910-12.

Procedures were developed to control the polymerization of thiophene and alkylthiophenes to obtain trimeric and pentameric derivatives. The structure of the thiophene trimer has been shown to be 2,4-di-(2-thienyl)-thiolane. The

Science and Technology

mechanisms involved in the polymerization of thiophene and the alkylation of thiophene are discussed and correlated. In previous work only highly insoluble amorphous products were obtained. However, by the use of 100 percent orthophosphoric acid, activated montmorillonite clays, and synthetic silica-alumina catalysts, liquid products are readily produced.

The Friedel-Crafts Reaction with Disubstituted Ethylene Oxides. I. Butylene and Isobutylene Oxides. WILLARD T. SOMERVILLE AND PAUL E. SPOERRI. *Jour. Am. Chem. Soc.*, **72** (1950), pp. 2185-7.

The reaction of disubstituted ethylene oxides with aluminum chloride and benzene was studied and was found to yield neophyl alcohol together with two hydrocarbons, $\alpha\alpha$-dimethyldibenzyl and meso-2,3-diphenylbutane, one of which is the product of the rearrangement. Both $\alpha\alpha$-dimethyldibenzyl and dimethylbenzylcarbinol yield meso-2,3-diphenylbutane as the rearrangement product upon treatment with aluminum chloride and benzene.

Manufacture: Processes and Plant

Plates vs. Vapor Rates by a Quick Simple Method. J. W. DONNELL AND C. M. COOPER. *Chem. Eng.*, **57** (1950), pp. 121-4.

The authors state that less than an hour of computation will give steam and plate needs for multicomponent separations, and that laborious plate-to-plate calculations are bypassed. The authors use the Fenske equation for minimum number of plates and the Underwood method for minimum reflux ratio, together with a correlation developed by themselves. Formerly, using plate-to-plate calculations, days and often weeks were required to do the same job. The results in those cases were on the whole less reliable than those obtained by the method here suggested. A typical problem is presented and covers a debutanizer. The problem is solved by the method given.

Absorption in Packed Towers. R. W. HOUSTON AND CHARLES A. WALKER. *Ind. Eng. Chem.*, **42** (1950), pp. 1105-12.

In spite of the complexity of flow in packed towers, considerable progress has been made in deriving satisfactory design methods. However, except in a few instances, it is not yet possible to design a tower with a few laboratory or pilot plant runs on the particular system and the particular packing to be used. Overall coefficients of absorption for various solutes from an air stream by water in a 12-inch column packed 2 feet deep with 1-inch Raschig rings are reported. Solutes used were ammonia, methanol, ethanol, and acetone. The range of gas diffusivities covered is twofold. Gas rates varied from 100 to 900 pounds per hour per square foot and water rates from 500 to 3000 pounds per hour per square foot. Liquid film coefficients were calculated by use of the Sherwood-Holloway relation. At liquor rates up to 2000 pounds per hour per square foot and gas rates up to 600 pounds per hour per square foot gas film coefficients for the various systems are correlated by the $\frac{1}{2}$ power of the gas diffusivity.

Factors Controlling Efficiency and Capacity of Sieve-Plate Extraction Towers. CYRUS PYLE, A. P. COLBURN AND H. R. DUFFEY. *Ind. Eng. Chem.*, **42** (1950), pp. 1042-7.

Factors influencing the efficiency and capacity of sieve-plate extraction towers were studied in a small glass extraction column, using the liquid-liquid system ethyl ether-acetic acid-water. It was found that at normal operating rates hole size, within limits, had little effect on efficiency and a higher percentage of free area was more advantageous than a lower percentage. Towers can be operated at higher capacity when the settling time of the two phases is short, and when the down pipes are flush with the surface of the plate from which they drop. Data are presented in tabular and graphical form and a bibliography of 7 references is included.

Liquid-Gas Interfacial Area in Packed Columns. JOEL WEISMAN AND CHARLES F. BONILLA. *Ind. Eng. Chem.*, **42** (1950), pp. 1099-1105.

Knowledge of the interfacial area for heat and mass transfer in packed towers has long been lacking. Air at room temperature was humidified in a column packed with $\frac{1}{2}$-inch solid glass and brass spheres, and the height of a transfer unit was obtained for both mass and heat transfer. On dividing these expressions by those for the height of a transfer unit for porous completely wetted spheres under the same conditions, the ratio of effective gas-liquid area to total packing area was obtained. For the conditions of

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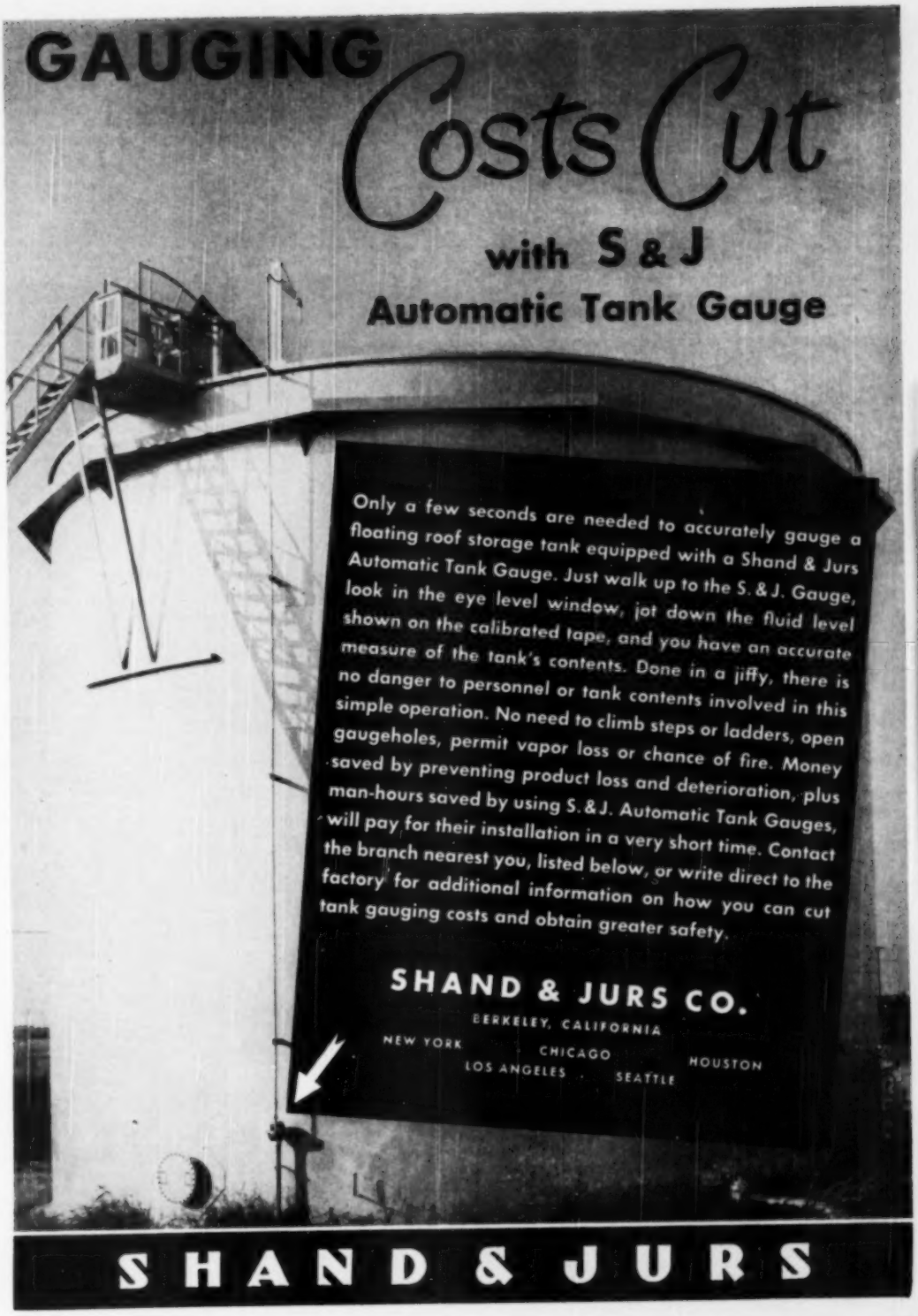
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the test the effective area for mass transfer ranged from 4 to 25 percent of the total and for heat transfer from 13 to 42 percent.

Fractional Solvent Extraction with Reflux. G. F. Asselin and E. W. Comings. *Ind. Eng. Chem.*, **42** (1950), pp. 1198-1205.

The effect of reflux in solvent extraction processes involving several components was studied. Two of these were essentially immiscible solvents, namely water and n-amyl alcohol, and two of the others were the compounds in a mixture to be separated. When a fifth component was used, it served as a separating agent between the other two solutes. A stagewise graphical method of calculation is presented that permits the computation of the results of extraction processes when reflux is employed. The position of the reflux line relative to the equilibrium curve permits quick estimation of the course the extraction will follow. Calculations for complete extraction units are given that indicate that the equilibrium relationships of the system must meet certain conditions, if reflux is to be effective. Its use is of greatest advantage with systems employing a fifth component as a separating agent.

Limiting Flow Phenomena in Packed Liquid-Liquid Extraction Columns. John H. Ballard and Edgar L. Piret. *Ind. Eng. Chem.*, **42** (1950), pp. 1088-98.

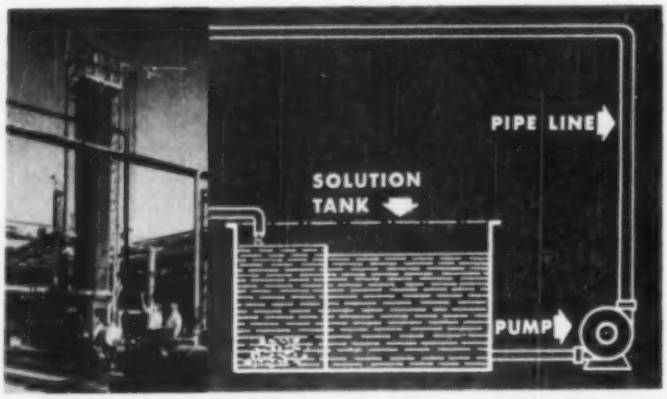
The mechanism of flow in packed liquid-liquid extraction columns at high rates of flow, which is more complicated than heretofore realized, was studied and classified. The flow mechanism of countercurrent liquid-liquid extraction columns was studied mainly with a 3¾-inch column packed with ½-inch porcelain Raschig rings. The liquid water was used as one phase, either contonuous or dispersed, and a number of fluid mixtures with widely different physical properties was used as the other phase. Visual observations supplemented the measurement of maximum column capacities. When the solvent, that is the phase that does not wet the packing, is dispersed, a transition point is reached at which drop size increases. The column may then flood, surge, or more commonly, change in flow mechanism to accommodate even higher flow rates by a phase reversal to essentially water-dispersed operations. This transition rate was correlated for a number of liquid systems with widely varying properties. Flooding points, which correspond to layer formation at one end of the column, lie considerably above this correlation. Previously published data on flooding points of gas-liquid systems in packed columns fall on the proposed curve. The flooding of columns in which the liquid that preferentially wets the packing is the dispersed phase is shown to have a different mechanism and to require a separate correlation.

Effect of Diffusivity of Gas-Film Absorption Coefficients in Packed Towers. Alan E. Subosky and Barnett F. Dodge. *Ind. Eng. Chem.*, **42** (1950), pp. 1112-19.

The object of the investigation reported was to study the effect of diffusivity in a packed tower by as direct a method as possible. To eliminate the possibility of liquid-phase resistance to mass transfer, the method of vaporizing pure liquids into an air stream was adopted. Three organic liquids and water were used, giving a 3.7-fold range of diffusivities. Care was taken in the design of the gas and liquid distributors to minimize end effects. The tower used was 8 inches in diameter and it was packed with 1-inch rings. The height of packing was varied from 4 to 12 inches, the liquor rate from 435 to 5000 pounds per hour per square foot. Most of the runs were made at 1600. The gas rate was varied from 140 to 500 pounds per hour per square foot. It was found that end effects were equivalent to 2.2 inches of packing. Gas-film coefficient was independent of liquor rate above a liquor rate of about 1000. k_{Ga} varied as the 0.72 power of the gas-flow rate and as diffusivity to the 0.15 power. The small effect of diffusivity in a packed tower indicates that the main resistance is caused by eddy diffusion in the turbulent core.

Toluene Extraction from Petroleum with Water Solutions. G. B. Arnold and C. A. Cochlan. *Ind. Eng. Chem.*, **42** (1950), pp. 1217-22.

A study of the recovery of toluene from a toluene concentrate prepared from hydroformed naphtha by use of liquid-liquid extraction with water at high temperatures has been described. The present paper is concerned with a continuation of the study of the recovery of toluene, and particularly with the use of water solutions as selective solvents. Batch equilibrium data are given for the recovery of toluene from the toluene con-



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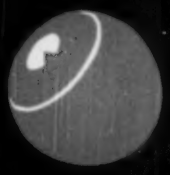

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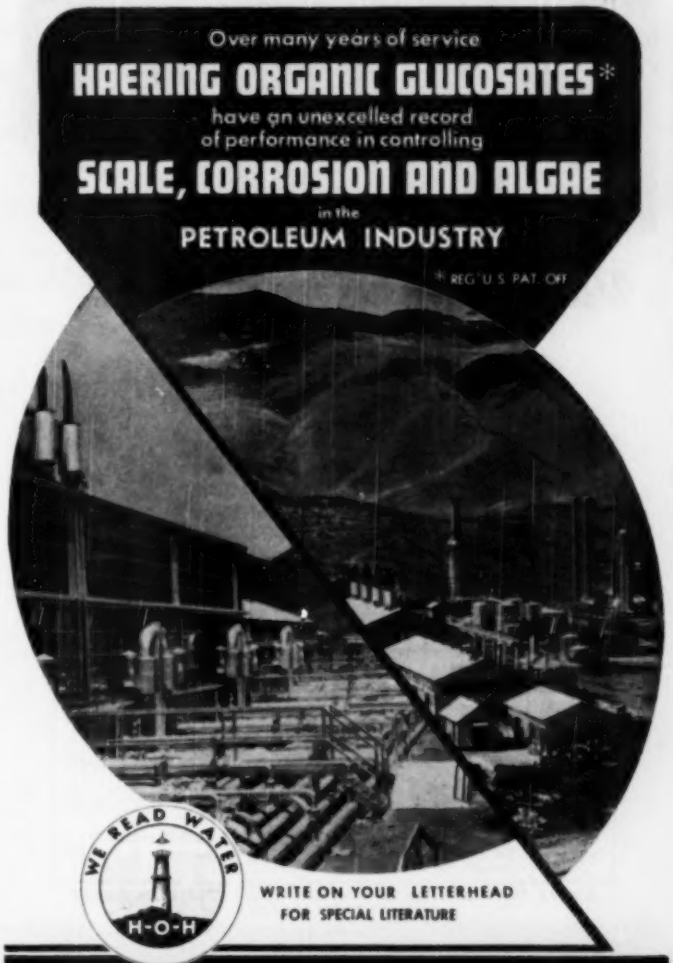
centrates by liquid-liquid extraction with a water solution of 20 percent ammonia at 274 and 232° C. and a water solution of 25 percent ethylene glycol at 302 and 274° C. Using these data calculations were made assuming a three-component system of toluene, naphtha, and solvent. The results are compared with similar calculations on the extraction of toluene with water alone at 274 and 302° C. The addition of ammonia or ethylene glycol to water effects some reduction in the solvent dosage and in the number of stages of extraction as compared to the use of water alone as solvent. The authors conclude that water solutions of ethylene glycol are the most desirable of the combinations studied.

Drop Formation in Two-Liquid-Phase System. CURTIS B. HAYWORTH AND ROBERT E. TREYBAL. *Ind. Eng. Chem.*, **42** (1950), pp. 1174-81.

The authors studied the dispersion from simple nozzles of one liquid into another immiscible liquid as a function of the physical properties and flow conditions of the system. The variables studied were: nozzle diameter, velocity through the nozzle, interfacial tension, viscosity of the dispersed and continuous phases, density of both phases, and dispersion of both light and heavy phases. More than 1000 photographs of the systems in operation were taken. It was found that drop size is uniform and increases with velocity through the nozzle up to 10 cm. per second, decreases and becomes less uniform from 10 to 30 c.m. per second, and is erratic and nonreproducible at still higher velocities. Drop size increases with increased interfacial tension, decreased difference in density between the phases, increased viscosity of the continuous phase, and increased nozzle diameter. It is independent of which phase is dispersed, and is practically unaffected by viscosity of the dispersed phase. An equation was developed that permits prediction of the drop size from system characteristics within 7.5 percent in the range 0 to 30 cm. per second velocity through the nozzle.

Production of Aromatics. C. H. MARSHALL. *Chem. Eng. Progress*, **46** (1950), pp. 313-18.

The history of toluene production from the time before the first world war to date is briefly reviewed. After 1938 the Ordnance Department began to take steps to establish plants for the recovery and synthesis of toluene from petroleum. Two processes were utilized, the first a recovery process that isolated naturally occurring toluene from petroleum crudes by distillation. This was followed by some purification by means such as extractive distillation and acid-treating plus rerunning to eliminate high boiling compounds from the desired aromatic. The second process was a synthetic one that utilized suitable catalysts to dehydrogenate naphthenes such as methylcyclohexane to give the corresponding aromatic hydrocarbon. The article is devoted to a description of the synthetic process known as hydroforming. Products from the process boiling above and below toluene constituted valuable blending components for aviation gasoline. Although the hydroforming process is rather specific for effecting dehydrogenation of naphthene, there are a number of secondary or side reactions, including dehydrocyclization of normal paraffins, rearrangement reactions of naphthenes or paraffins, such as isomerization, various pyrolytic decompositions, formation of small quantities of high boiling material, probably through alkylation and condensation, hydrogenation of olefins, and decomposition of sulfur-containing compounds. Of these side reactions, the cracking decomposition is the most extensive with virgin naphtha feed stocks because the hydroforming reaction is conducted normally in the temperature range 900 to 1000° F. Hydrogenation of olefins is usually the most important side reaction that occurs when running cracked naphtha feed stocks. Carbon is removed periodically from the catalyst by oxidation and the catalyst is restored essentially to its original activity. The hydroforming process is characterized by dehydrogenation in the presence of hydrogen added in excess of that produced from the dehydrogenation of naphthene. To accomplish this a portion of the hydrogen-rich light gas is recycled. The hydroforming process is employed in the industry to produce aromatic compounds of high purity to make aviation gasoline blending agents, or to raise the antiknock value of petroleum naphthas boiling in the range 200 to 450. A greater improvement in octane quality for a given gasoline yield is obtained than by straight thermal reforming. A stable low-sulfur gasoline that is usually doctor sweet is made and little or no finishing treatment is required. The process is flexible and the product octane can be adjusted to the desired level, over a considerable range. Flow diagrams are given of the wartime opera-



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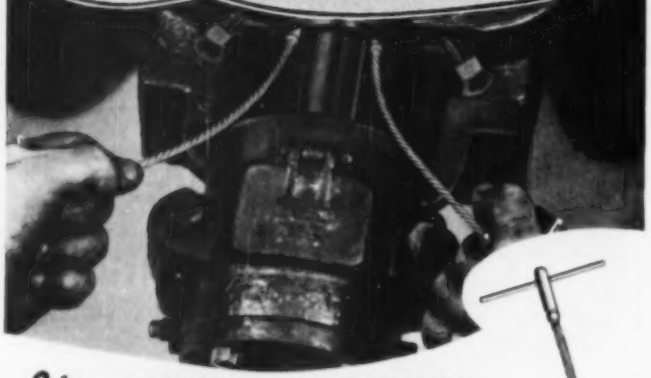

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tions of the Baytown Ordnance plant and also of the post-war operation of this plant.

Commercial Extraction Equipment. V. S. Morello and Noland Poffenberger. *Ind. Eng. Chem.*, **42** (1950), pp. 1021-35.

The paper summarizes the available contemporary data on commercial extraction equipment. The major commercial applications of liquid-liquid extraction processes are given in tabular form. A classification of extraction equipment is presented. Different types of apparatus are shown diagrammatically and are briefly described. A comprehensive table presents extraction applications, type of extractor, solvents, densities of the liquid materials, size of the extractor, number of theoretical contacts and stages, rates of flow, and concentration changes. A bibliography containing 122 references pertaining to extraction is included.

Products: Properties, Utilization and Analysis

Environmental Cancer and Petroleum. Lt. Col. S. J. M. Auld, O. B. E., M. C. *Journal Inst. of Petroleum*, **36** (1950), pp. 235-53.

The author reviews present knowledge of the carcinogenic hydrocarbons. The petroleum industry has been concerned with skin cancer amongst paraffin workers, particularly in shale plants, among lubricating oil users, such as "mule-spinners' cancer," and in the use of cutting oils. There is possibility of carcinogenic hydrocarbons in selective solvent extracts and in cracked oils of high boiling point. A committee has been organized by the Medical Research Council in the study of problems of the carcinogenic action of mineral oils and compounds of other origin with which mineral oils may be combined in use. The British committee is cooperating with the American Petroleum Institute medical committee and arrangements have been made for the exchange of information and results.

Load Capacity Rating of Lubricants. V. H. Ebix. *Jour. Inst. of Petroleum*, **36** (1950), pp. 295-302.

The author briefly reviews the subject of the properties of lubricating oils in relation to their use. In engines operating at presently higher temperatures lubricating value is the predominant property that is called into play. Solvent-refined oils, without additives, are often found deficient in this property, with the result that "scuffing" occurs. It has always been difficult to rate lubricants in terms of their ability to lubricate. The property has been expressed as load capacity, film strength, etc., as determined by some arbitrary test. Such procedures do not always reproduce properly or correlate with service conditions. Some success has been achieved in recent years with the development of the IAE (now the MIRA) 3¼-inch oil-testing machine. There are certain drawbacks to the extensive use of this method. For instance, it is necessary to use accurately fabricated and ground test gears. The author describes a machine that employs simple test-pieces that can be re-used

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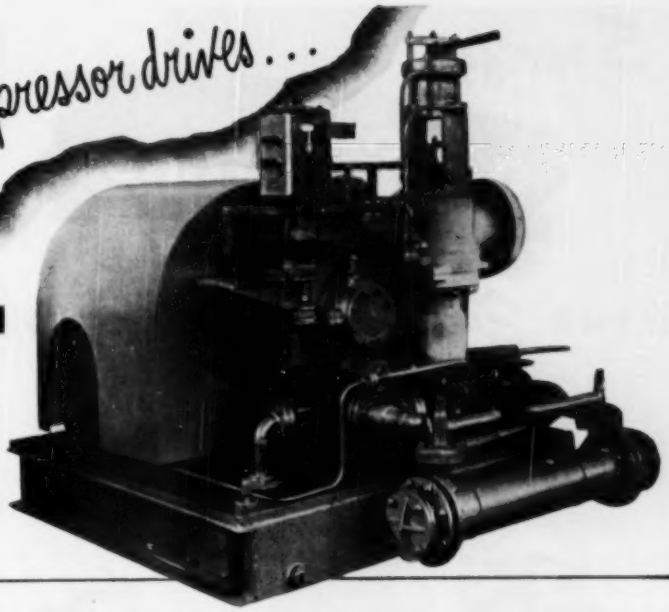

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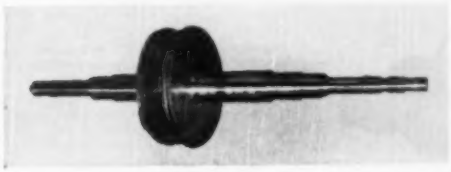

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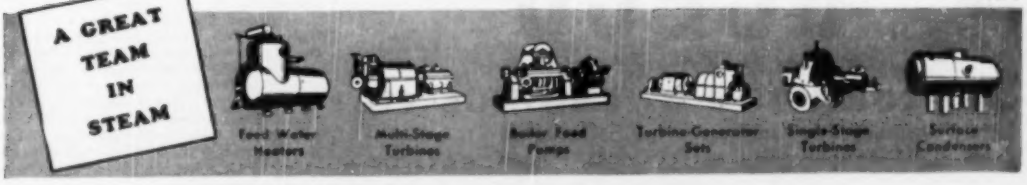

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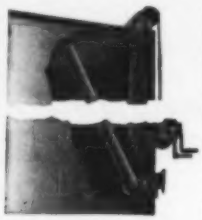

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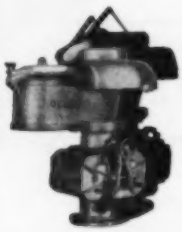

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indefinitely. The procedure is simple and rapid. The results have a similar trend to those obtained on the IAE-type gear machine, and have shown useful correlation with service conditions. The article is illustrated with photographs and drawings.

Detergency of Carbon Black. Part II. F. H. Garner, C. W. Nutt and M. F. Montabl. *Jour. Inst. of Petroleum*, **36** (1950), pp. 292-4.

As part of a research program concerned with the study of "detergency in lubricating oils" a study was made of the influence of various additives on the particle size of carbon black dispersed in toluene solutions of compounds under standard conditions. The investigation shows a correlation between the particle size and the dispersive power of the medium as measured by a standard settling-rate test. Microphotographs are included in the article.

Comparison of Melting Point Methods for Wax. A. W. Marshall. *Analytical Chem.*, **22** (1950), pp. 842-4.

There are several methods for the determination of the melting points of waxes; many of these methods do not agree on the melting point value of the same wax, and some are affected by the type of wax. An investigation was made of a number of melting point determination methods as applied to various waxes, ranging from paraffins of low melting point, through plastic microcrystalline and high melting paraffins of microcrystalline waxes, and including three oxidized hydrocarbon waxes. Methods used were those encountered most generally in the trade. The author concludes that there are three critical points near the transition point from solid to liquid wax. First is the thaw point or the eutectic temperature of the wax, this is approximated by the ring and plunger method. The second is the melt point or the point at which all wax is actually liquid. This is best evaluated by the ASTM paraffin melting point. The third is the flow point or the point at which viscosity is reduced to about 50 centipoises. This is best evaluated by the ASTM petrolatum melting point method. High melting, hard microcrystalline waxes are subject to viscosity hysteresis at the melting point, but other petroleum waxes are not.

The Removal of Acetylene from Hydrocarbon Gases. B. E. V. Bowen, J. Howlett and W. L. Wood. *Jour. Soc. Chem. Ind.*, **69** (1950), pp. 65-9.

The presence of acetylene in gas mixtures from vapour-phase cracking is a complication in the use of reagents for the concentration of ethylene. The authors describe two methods for eliminating the acetylene from ethylene-containing gases, one for ethylene fractions containing no more than traces of hydrogen, and the other for gases containing hydrogen in substantial quantities. In the absence of hydrogen, the acetylene can be preferentially oxidized, using copper as catalyst. The small amount of residual excess oxygen necessarily added reacts with ethylene on the same catalyst and at the same temperature to give a gas free from both acetylene and oxygen. If there is more than 4 mole percent

hydrogen and small amounts of acetylene impurity, such as 0.5 to 1.0 percent, the acetylene can be preferentially hydrogenated without affecting the ethylene by use of a reduced nickel-chrome catalyst, the preparation of this catalyst is described. The efficiency of the catalyst is adversely affected by the presence of certain sulfur compounds.

Determination of Traces of Sulfur in Organic Compounds. R. E. Holeton and A. L. Lynch. *Analytical Chem.*, **22** (1950), pp. 819-22.

The more commonly used method for the determination of sulfur in organic compounds by combustion are not applicable to the determination of total sulfur in the range of 1 to 200 parts per million. The method described involves combustion with excess air in a heated tube using a special atomizer to deliver the sample as a fine spray in a stream of air to the combustion zone at an easily controlled rate. Improvements in the absorption of sulfur dioxide and in the nephelometric determination of sulfur as barium sulfate are also described. Better absorption of the oxides of sulfur was obtained by condensing water from the combustion in a chilled trap containing sodium perborate solution before passing the gases through the absorbers. It was found that precipitation from ammoniacal solution, in the presence of gum arabic as a stabilizer, improved the stability of the barium sulfate colloid. The method has been successfully applied to liquids such as cetane, as well as to solutions of solids, such as naphthalene. The accuracy is of the order of 5 to 10 percent of the sulfur present.

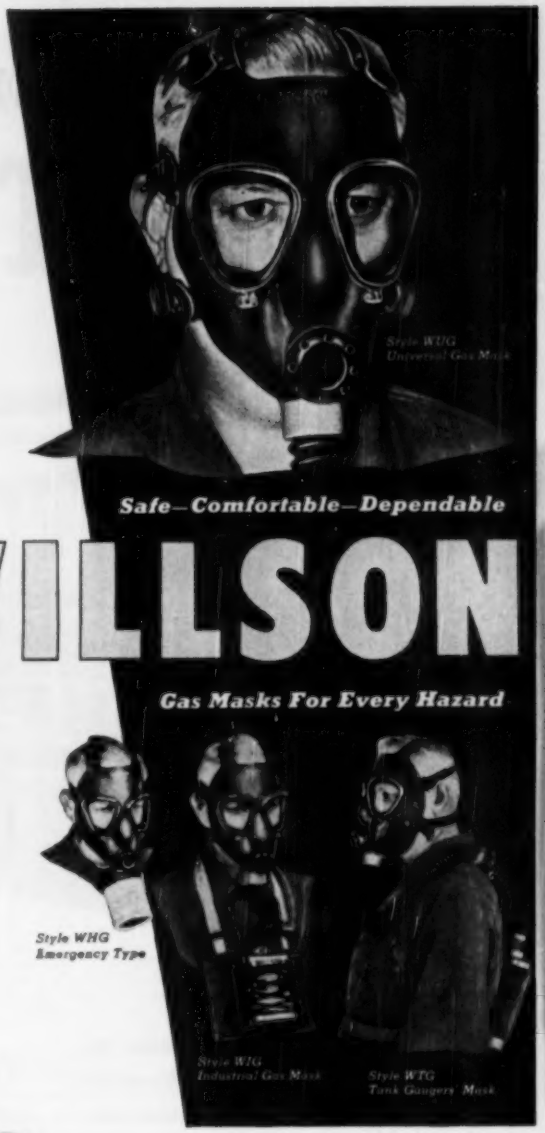
Schoch Acetylene Process Ready for Commercial Use

A method of making acetylene from natural gas and liquid hydrocarbons, developed by Dr. E. P. Schoch and associates of the University of Texas bureau of industrial chemistry, is ready for commercial use, according to University officials. Dr. Schoch said his process will produce acetylene for five to six cents a pound compared with a cost of seven to eight cents a pound for present carbide methods.

The Schoch process makes acetylene by shooting an electrical discharge through natural gas or other petroleum fractions between a metal strip and a rotating blower wheel. Approximately $587,000 worth of research has been spent since 1929 by Schoch and others in developing the process. Industry contributed $312,000; the state, $275,000.

Ohio Oil Safety Record Basis for Council Award

First place award for no lost-time accident during the year was given The Ohio Oil Company's refining division in the Group B petroleum section of the National Safety Council's Safety Contest for 1949. The petroleum section of the contest includes entrants from the U. S., Canada, Mexico, and Venezuela. More than 22 million barrels of crude were processed at the company's two refineries at Robinson, Ill., and Lovell, Wyo., without a lost-time accident.



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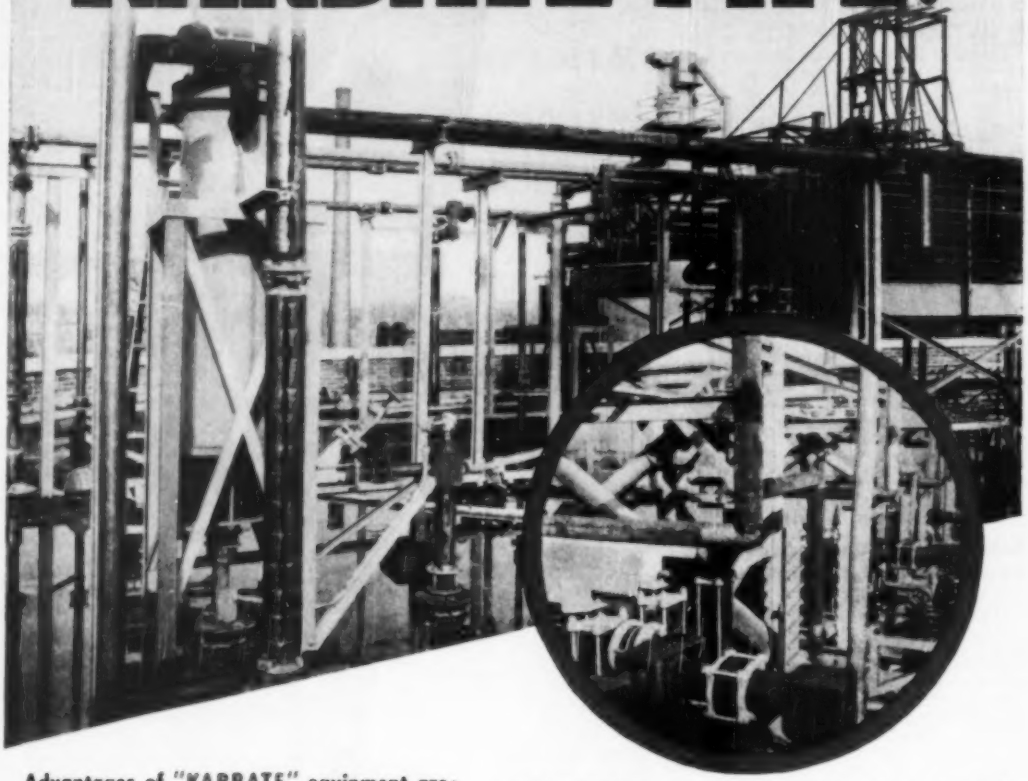

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, May 16, 23, 30 and June 6, 1950)

REFINING

U.S.P. 2,507,560. Process for Breaking Petroleum Emulsions. M. DeGroote and B. Keiser to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by a demulsifier including a hydrophile, hydroxypolyalkoxy compound obtained in a manner claimed in detail.

U.S.P. 2,507,910. Proccess for Breaking Petroleum Emulsions. B. Keiser and M. DeGroote to Petrolite Corporation, Ltd.

Petroleum emulsions of the water-in-oil type are broken by a hydrophile oxyalkylated synthetic resin prepared by the oxyalkylation of an infusible synthetic resin. An alpha-beta alkylene oxide with not more than 4 C atoms is used for this purpose.

U.S.P. 2,508,038. Process of Refining Hydrocarbons. E. Manning, Jr., to Shell Development Company.

A hydrocarbon mixture containing normal paraffinic and other hydrocarbons is treated with an anhydrous mixture of sulfuric and phosphoric acids as obtained by mixing concentrated H_2SO_4 with P_2O_5. A hydrocarbon phase enriched in normal paraffinic hydrocarbons is produced, and an acid phase is obtained which contains at least a portion of the other hydrocarbons.

U.S.P. 2,508,723. Separation of Hydrocarbons. B. J. Mayland, F. N. Ruehlen and E. E. White to Phillips Petroleum Company.

A mixture of hydrocarbons of different types of narrow boiling range, e.g. of paraffins, cycloparaffins, olefins, diolefins, and/or aromatics, is mixed with diethylene glycol-bis-chloroformate. Two phases are formed, and at least one of the close boiling hydrocarbons can be recovered from one of these phases.

U.S.P. 2,508,922. Separation of Dienes. D. B. Luten, Jr., K. W. Hedberg, and A. DeBenedictis to Shell Development Company.

Details are claimed for the separation of isoprene and cyclopentadiene from a hydrocarbon mixture by first dimerizing the mixture to convert cyclopentadiene to dicyclopentadiene. The separated fraction comprising this dimer and isoprene is treated to reconvert the dimer to cyclopentadiene and remaining dimer is subjected to further treatment.

U.S.P. 2,509,044. Separation of Low Molecular Weight Hydrocarbons from Petroleum Mixtures. J. A. Patterson to Standard Oil Development Company.

Details are claimed of a process for separating by fractionation ethane and ethylene from a predominantly C_2-C_4 hydrocarbon fraction.

U.S.P. 2,509,136. Process and Apparatus for Concentrating Dilute Solutions. P. W. Cornell to Gulf Oil Corporation.

Details are claimed of a process for recovering volatile water-soluble organic compounds boiling below the boiling point of water from dilute aqueous solutions particularly from the aqueous solutions produced by by-products in a Fischer-Tropsch synthesis operation.

U.S.P. 2,509,486. Separation of Hydrocarbons. J. D. Danforth to Universal Oil Products Company.

A hydrocarbon mixture containing hydrocarbons of different types is passed upwardly through a stationary bed of adsorbent silica particles. A desorbing liquid is thereafter passed into this bed to displace the hydrocarbons in the order of their preferential displacement from the adsorbent. Aromatics, olefins, naphthenes, and paraffin can thus be separated.

U.S.P. 2,509,855. Isobutylene Purification System. W. H. Rupp and J. W. Packie to Standard Oil Development Company.

A mixture of C_4 hydrocarbons containing isobutylene, butene-1, butene-2, butadiene, isobutane and n-butane is absorbed in an acid. The isobutylene-acid extract formed is contacted with a saturated aliphatic hydrocarbon of 4-8 C atoms free of unsaturates. A liquid hydrocarbon phase is separated. Isobutylene is then regenerated from the remaining acid extract.

U.S.P. Re. 23,239. Inhibitor for Gasoline. R. H. Rosenwald and J. A. Chenicek to Universal Oil Products Company.

Olefin-containing hydrocarbon oils, particularly gasolines, are stabilized (e.g. as to color, anti-knock value and low gum content) by the addition of a minor portion of a 2-alkyl 1-4-alkaxyphenol.

U.S.P. 2,510,847. Distillation of Polymerizable Diolefins. S. W. Wilson to Standard Oil Development Company.

Hydrocarbon mixtures containing diolefins with 4-6 C atoms, traces of sulfur, sulfur compounds and other hydrocarbons polymerizable by acid traces are fractionally distilled in the presence of a polymerization inhibitor consisting of an amine of a bi-nuclear aromatic hydrocarbon, such as phenyl-beta-naphthylamine, and hydroxy bi-nuclear aromatic hydrocarbon, such as alpha-naphthol. The diolefins are recovered.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,507,496. Molded Contact Masses. G. R. Bond, Jr., to Houdry Process Corporation.

Catalytically active molded units consist of a core of catalytically inert solid refractory material and a hard shell of catalytically active solid adsorptive material. The shell forms a continuous structural member of substantial thickness and has sufficient strength to withstand crushing forces during use.

U.S.P. 2,507,499. Recovery of Boron Fluoride. G. N. Cade to Phillips Petroleum Company.

In the conversion of hydrocarbons by means of BF_3-HF-H_2O catalyst, the acid-soluble boron-and fluorine-containing oil formed is separated from the bulk of the catalyst. The separated oil is oxidized to form B_2O_3. The latter is reacted with a stoichiometric excess of HF to form BF_3-HF-H_2O mixture for reuse.

U.S.P. 2,507,526. Azo Catalysts in the Preparation of Olefin-Sulfur Dioxide Resins. R. A. Jacobson to E. I. du Pont de Nemours & Company.

Solid polmers are made from SO_2 and olefins having hydrogen on doubly bonded carbon in the presence of a catalyst consisting of an azo compound wherein the —N=N-group is attached to different carbons aliphatic in character, each further bonded to a nitrile, carboxalkoxy, or carbonamide group. Alpha, alpha'-azodiisobutyronitrile is an example of the catalyst.

U.S.P. 2,507,625. Catalyst for Conversion of Hydrocarbons. C. H. Ehrhardt to Universal Oil Products Company.

A hydrocarbon conversion catalyst is

prepared by calcining a silica-gel-magnesia composite impregnated with an ammonium phosphate solution. The magnesia forms a minor proportion in the composite, and the residual phosphorus compound of the phosphate shall be present in the catalyst in an amount of 0.5-5 percent by weight.

U.S.P. 2,508,867. Separation of Preferred Fractions from Apparently Homogeneous Gel Particles. L. D. Rampino to Shell Development Company.

A mixture of microporous gel particles in granular form which are homogeneous as to chemical composition, pore volume and average pore size but differ from one another in the time required to come to equilibrium with a sorbable material is contacted with a sorbable material for a period of time less than that required to reach complete equilibrium in all particles. The particles are then separated into at least two fractions on the basis of the thus developed inhomogeneity, whereupon the sorbed material is removed from at least one of the fractions. Improved microporous mineral gel useful as catalyst, catalyst carrier, adsorbent or the like is thus obtained.

U.S.P. 2,509,014. Method and Apparatus for Heat-Treating Particle Form Solids. J. W. Payne and E. V. Bergstrom to Socony-Vacuum Oil Company, Inc.

Details are claimed of a continuous method for heat-treating particle form adsorbent materials, e.g. catalyst particles, at a predetermined temperature without appreciable attrition of the solid particles.

U.S.P. 2,509,900. Method for Supplying Tempering Steam and Regeneration Gas to a Catalyst. D. J. Wormith to Standard Oil Development Company.

Details are claimed of a process for regenerating a hydrocarbon conversion catalyst and employing it on a steam-reactant feed.

U.S.P. 2,510,189. Supported Catalyst and Preparation Thereof. P. G. Nahin and H. C. Huffman to Union Oil Company of California.

A catalyst carrier is impregnated with a catalytic agent consisting of an axide of a Group VIII metal, e.g. Co, combined with an oxide of a metal of the left hand column of Group VI of the periodic table, e.g. Mo. Details of the process for forming the impregnating solution are claimed.

U.S.P. 2,510,803. Vanadium Pentoxide Catalysts. W. C. Cooper to Pittsburgh Coke & Chemical Company.

A catalyst useful in the oxidation of organic compounds, e.g., that of naphthalene to phthalic anhydride, comprises solid, inert carrier particles having an adherent coating of 0.1-1 percent by weight of V_2O_5. This coating is produced by contacting the carrier with an aqueous solution of collodial V_2O_5 comprising 0.1-5 percent V_2O_5 and then evaporating the water.

U.S.P. 2,510,823. Method of Sintering a Catalyst. R. W. Krebs to Standard Oil Development Company.

In a Fischer-Tropsch synthesis in the presence of a finely divided, fluidized iron catalyst, the catalyst particles are maintained in a fluidizable size. For this purpose, catalyst which has undergone physical disintegration is withdrawn and subjected to sintering temperatures in a reducing atmosphere while in the form of a fluidized mass, so that finer particles are agglomerated to form coarser particles of fluidizable size. After removal of finer particles by aeriform classification, the sintered coarser particles are cooled and immediately returned without grinding to the reaction zone.

U.S.P. 2,510,864. Catalyst for Fluorination. G. H. Cady to the U. S. Atomic Energy Commission.

A catalyst useful in the fluorination of hydrocarbons is obtained by plating a heat conducting metal resistant to fluorine with Ag, Co Mn, or Ce and reacting the plating metal with a fluorinating agent.

CRACKING AND REFORMING

U.S.P. 2,507,538. Method and Apparatus for Catalytic Treatment of Gases. E. B. Miller.

In a process for the catalytic cracking of vaporized hydrocarbons with regeneration of spent catalyst, a series of separated thin beds of catalyst is rotated directly in succession and continuously relative to and through a reaction and a

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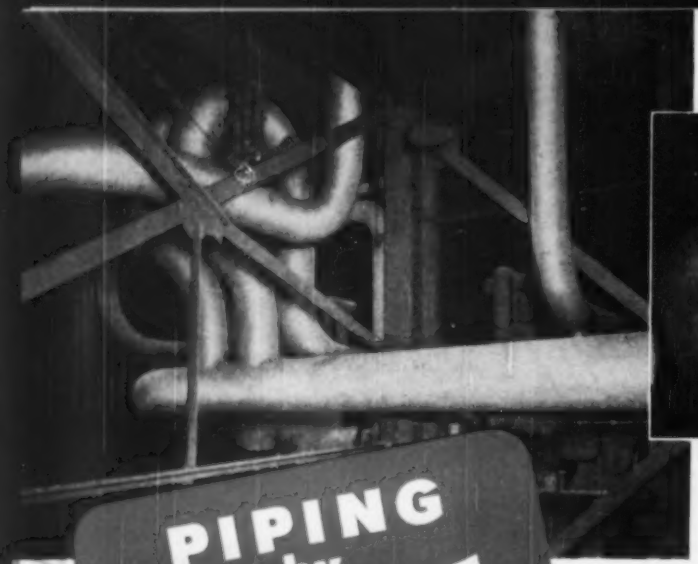
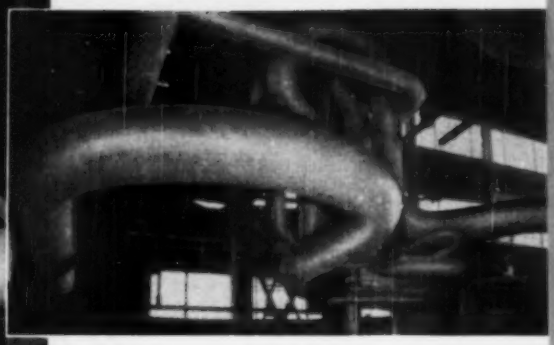
Figure 15 Manual Valve in shut-off service is a valuable companion to the Domotor Control Valve. By taking advantage of the interchangeable characterized trims offered, this valve becomes ideal for batch and non-continuous fluid processing control. Operates over the same service range as the DOMOTOR.





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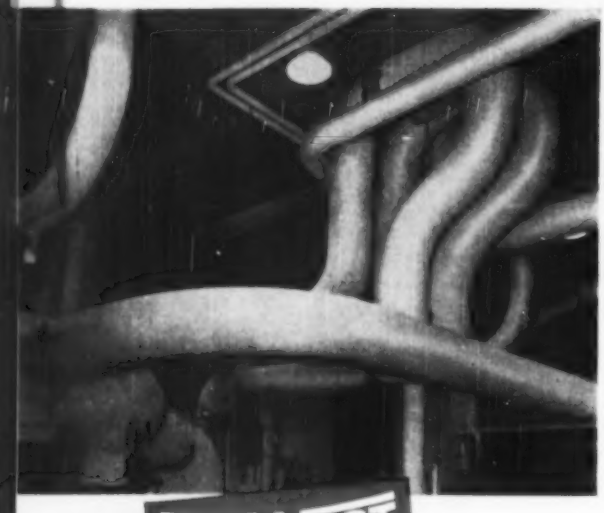

The first installation of a mercury-unit power plant designed and built as a complete power generating unit . . . the Schiller Station of the Public Service Co. of New Hampshire at Portsmouth, N. H. is a notable achievement. When operating at designed rating of 40,000 kw and using Bunker C fuel oil, the heat rate is 9200 Btu per net kwhr.

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regenerative zone. Further details are claimed.

U.S.P. 2,507,861. Solvent Refining of Light Oils. R. E. Manley to The Texas Company.

Diesel fuel oil is produced from residual crude oil relatively high in sulfur and nitrogen compounds by subjecting the crude oil to thermal cracking conditions and then treating a gas oil fraction thereby obtained with an alumina-silica cracking catalyst under cracking conditions. A second gas oil fraction thus produced is subjected to solvent extraction with furfural saturated with water. The raffinate oil formed is free from nitrogen and contains not more than 0.16 percent sulfur. It has a relatively high cetane number.

U.S.P. 2,508,014. Catalytic Reforming of Gasoline. D. D. Davidson to Shell Development Company.

A straight-run gasoline fraction boiling between 185-500° F. and having a clear F-2 octane number below 48 is continuously vaporized and contacted in the presence of at least 2500 cubic feet per barrel of hydrogen at a liquid hourly space velocity of 0.5-3, a temperature of 825-1025° F., and a pressure of at least 500 psi. with an impregnated molybdenum oxide-alumina catalyst promoted with silica and zinc oxide. Upgraded motor fuel is continuously obtained.

U.S.P. 2,510,673. Reforming Gasoline. W. G. Annable to The Pure Oil Company.

Details are claimed of a process for preparing gasoline of high octane value from gasoline of low octane value, obtained from a naphtha fraction, by a reforming operation combined with fractional distillation.

POLYMERIZATION AND CONVERSION

U.S.P. 2,507,523. Conversion of Hydrocarbons. E. J. Houdry to Houdry Process Corporation.

Heavy or residual hydrocarbon fractions are converted without recovery of tarry or asphaltic materials by a process claimed in detail. The charging stock is contacted together with cracked hydrocarbon vapors in a first zone with solid, inert, heat resistant material at elevated temperature. The vaporized products are fractionated to produce distillate fractions which are then at least partially cracked. Light products are obtained.

U.S.P. 2,507,603. Rendering Inocuous Fluid Fluoride Catalyst. A. J. Killgore to Phillips Petroleum Company.

A fluid fluoride catalyst used in an organic reaction is rendered inocuous by immediately destroying its activity after use. For this purpose, the catalyst is contacted with a dissolved halide, other than the fluoride, of Mg, Ca, Sr, or Ba. The process is claimed in detail.

U.S.P. 2,507,864. Polymerization of Olefins. F. J. Moore and M. M. Steward to The Texas Company.

A C_3 olefin is polymerized in contact

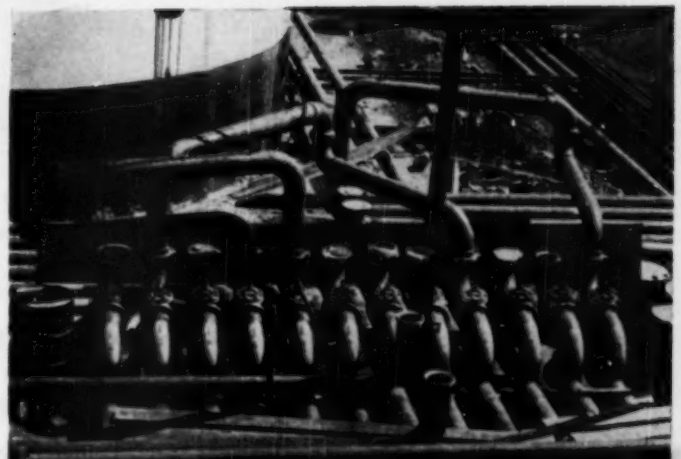

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FIG. 208
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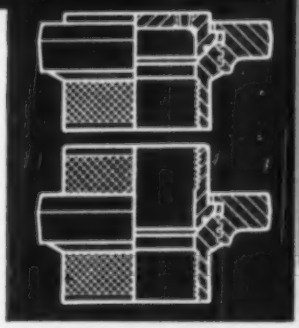

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with a granular synthetic gel catalyst of theacid treated zeolith type under special conditions.

U.S.P. 2,508,120. Method and Apparatus for Conversion of Hydrocarbons. H. E. Lonngren, New York.

Endothermic conversion, e.g., cracking of fluid hydrocarbons is continuously effected while causing molten lead, zinc, tin, bismuth or cadmium, or alloys of these metals to flow at a temperature of 1000-2000° F. through heating, vaporizing, scrubbing and reaction zones in direct contact with the oil to be treated. Coke formed adheres to the heated metal but not to the metal portions of the apparatus.

U.S.P. 2,508,734. Emulsion Polymerization with a Composition Comprising Diazo Thioether-Ferricyanide-Mercaptan-Dihydroxy Aromatic Compound. J. E. Troyan to Phillips Petroleum Company.

The emulsion polymerization of a monomeric material preferably comprising a 1,3-diolefin and a copolymerizable unsaturated compound, such as styrene, for the formation of rubber-like compounds is effected in the presence of an ortho or para dihydroxy aromatic compound of the formula $R_5Ar(OH)_2$ where Ar is a benzene or naphthalene nucleus and each R is hydrogen, alkyl, cycloalkyl, aryl, or aralkyl, each having not more than 7 C atoms and the sum of the C atoms in R_5 being not greater than 7, together with a diazo thioether of the formula $R—N=N—S—R^1$ where R is an aromatic radical and R^1 is an aromatic cycloalkyl, or aliphatic radical, a water-soluble ferricyanide and a mercaptan with 4-20 C atoms.

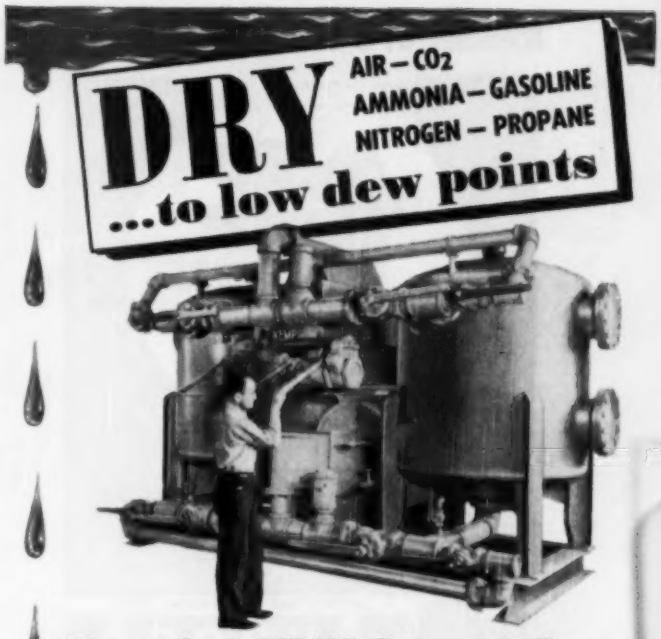
U.S.P. 2,508,743. High-Pressure Low-Temperature Catalytic Conversion of Carbonmonoxide. F. H. Brumer to The Texas Company.

Details are claimed of a process for converting CO-containing reaction mixtures, e.g. for converting a mixture of COH_2 and olefin into carbonylic products at a temperature below 400° F. and a pressure above 150 psi. in the presence of an iron group metal catalyst. The effluent of conversion in a first zone contains metal carbonyl and is treated in a second zone at a pressure below 100 psi.

U.S.P. 2,508,744. Propylene Polymerization. C. S. Carlson, R. S. Merrington, and F. A. Biribauer to Standard Oil Development Company.

Propylene is selectively polymerized in a liquid C_5 hydrocarbon fraction with gaseous BF_3 activated by a liquid oxygen-containing compound. The resulting reaction mixture is maintained in a separation zone at a pressure and temperature to maintain C_5 hydrocarbons in the liquid phase with a minor proportion of BF_3 dissolved therein. Gaseous BF_3 catalyst substantially free of organic compounds is withdrawn from this zone and recycled to the reaction zone.

U.S.P. 2,508,993. Method for Conducting Gaseous Reactions in the Presence of a Moving Particle Form Solid. J. A. Crowley, Jr., to Socony-Vacuum Oil



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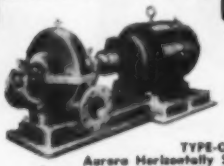

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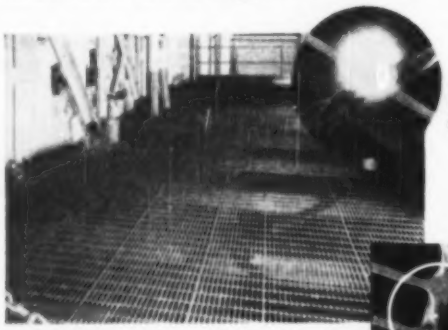

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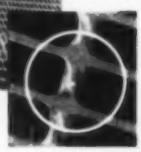

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WRITE FOR BULLETIN 3296

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BLAW-KNOX ELECTROFORGED STEEL GRATING

Patents

Company, Inc.

Details are claimed of a method for conducting thermochemical conversions of fluid hydrocarbons at controlled elevated temperatures in the presence of a moving particle-form contact material, e.g. for catalytic cracking of hydrocarbons at temperatures of 1000-1200° F. to produce high yields of aviation gasoline and C_4 fractions.

U.S.P. 2,509,019. Method and Apparatus for Conversion of Hydrocarbons with Moving Bed of Solids. T. P. Simpson, F. E. Ray, and R. Lee to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for the conversion of hydrocarbons in the presence of a continuous compact bed of catalyst within a confined reaction zone. The catalyst is caused to move downwardly through this zone by continuously supplying fresh catalyst to the upper portion of the bed and removing contaminated catalyst from its lower portion. The hydrocarbons are first also moved downwardly through an upper portion of the bed, whereupon the direction of their flow is reversed within an enlarged lower portion of the bed to effect disengagement of the hydrocarbons from the bed.

U.S.P. Re. 23,237. Apparatus for Catalytic Conversion of Hydrocarbon Vapors. C. S. Reed and A. H. Schutte to The Lummus Company.

A closed cycle catalytic reaction system is claimed in which a powdered catalyst is continuously passed through a reaction zone, a regeneration zone, and is then recycled. An improved control for the cycle is provided with independently maintained pressures for the various parts of the cycle.

U.S.P. 2,509,495. Manufacture of Interpolymers of Aromatic Vinyl Hydrocarbons and Oils. W. T. C. Hammond to Sherwin-Williams Company.

A mixture of an aromatic vinyl hydrocarbon (such as styrene), a drying oil (10-75 percent of the mixture) and sulfur (½-5 percent of the drying oil) is heated at polymerizing temperatures. An interpolymer is obtained.

U.S.P. 2,509,745. Fluidized Catalyst Process for Conversion of Hydrocarbons. W. R. Riggs to Sinclair Refining Company.

Details are claimed of a fluid catalyst process for the conversion of hydrocarbons with continuous stripping, regeneration and recycling of the used catalyst.

U.S.P. 2,509,751. Fluid Catalyst Process for Conversion of Hydrocarbons with Stripping and Regeneration of Fouled Catalyst. K. M. Watson to Sinclair Refining Company.

In a catalyst process of the type according to U.S.P. 2,500,745, uniform contact between the catalyst and a gaseous medium is effected by passing the latter as a plurality of confined streams upwardly through a succession of vertically spaced beds of the catalyst. Further details are claimed.

U.S.P. 2,510,444. Apparatus for Pyrolytic Conversion of Hydrocarbons. K. M.

IF the compressed air in your instrument lines and process-control lines holds moisture, rust or oil, you're in trouble. Instrument readings can go haywire . . . air-line valves can stick . . . controls can go entirely "off the beam" . . . the whole shootin' match can literally blow up!

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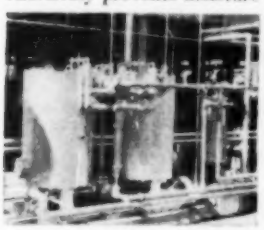

Courtesy of Standard Oil & Gas Company

The photograph illustrates a typical unit used for maintaining process-control-line air in proper condition. Air is dried by being passed through beds of ALCOA Activated Alumina, alternately, in the two towers at the left. At the right is an oil filter—also charged with ALCOA Activated Alumina—which cleans the air of oil and suspended impurities that may enter system from the compressors.

This thorough conditioning of the air helps insure the efficiency of process-control systems . . . reduces maintenance and operating hazards. (This type of equipment also is used for industrial compressed air and paint-spray systems.)

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There's an AIRETOOL Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

Patents

Watson to Sinclair Refining Company.

An apparatus is claimed which is especially useful in the pyrolytic conversion of hydrocarbons in the presence of finely divided solid catalyst. It provides means for effecting uniform contact between the hydrocarbon vapors and the catalyst.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,507,510. Catalytic Reduction of Carbon Oxide by Hydrogen. W. G. Frankenburg to Hydrocarbon Research, Inc.

Normally liquid hydrocarbons boiling in the gasoline range are produced by passing a CO/H_2 mixture into contact with a titanium boride catalyst at a temperature of 500-750° F.

U.S.P. 2,509,204. Catalytic Conversion. J. P. Bilisoly to Standard Oil Development Company.

A reduced catalyst for a Fischer-Tropsch synthesis consists of 40-95 parts by weight of MgO, 3-50 parts of Fe_2O_3, 0.5-20 parts of CuO, 0.5-10 parts of K_2O, and 25-51 parts of CoO according to analysis on an oxide basis. Valuable motor fuels are produced from a CO/H_2 mixture with this catalyst at temperatures of 400-500° F. and pressures not substantially above atmospheric.

U.S.P. 2,509,869. Hydrocarbon Synthesis. I. Kirshenbaum to Standard Oil Development Company.

Synthesis proportions of CO and H_2 are contacted at temperatures of 550-750° F. and pressures of 150-650 psi. with a dense turbulent fluidized catalyst consisting of a reduced composite of 60-90 percent of chromia, 5-40 percent of iron oxide, and 0.5-5 percent of an alkali metal compound promoter. The catalyst possesses high disintegration resistance and little tendency to carbon deposition.

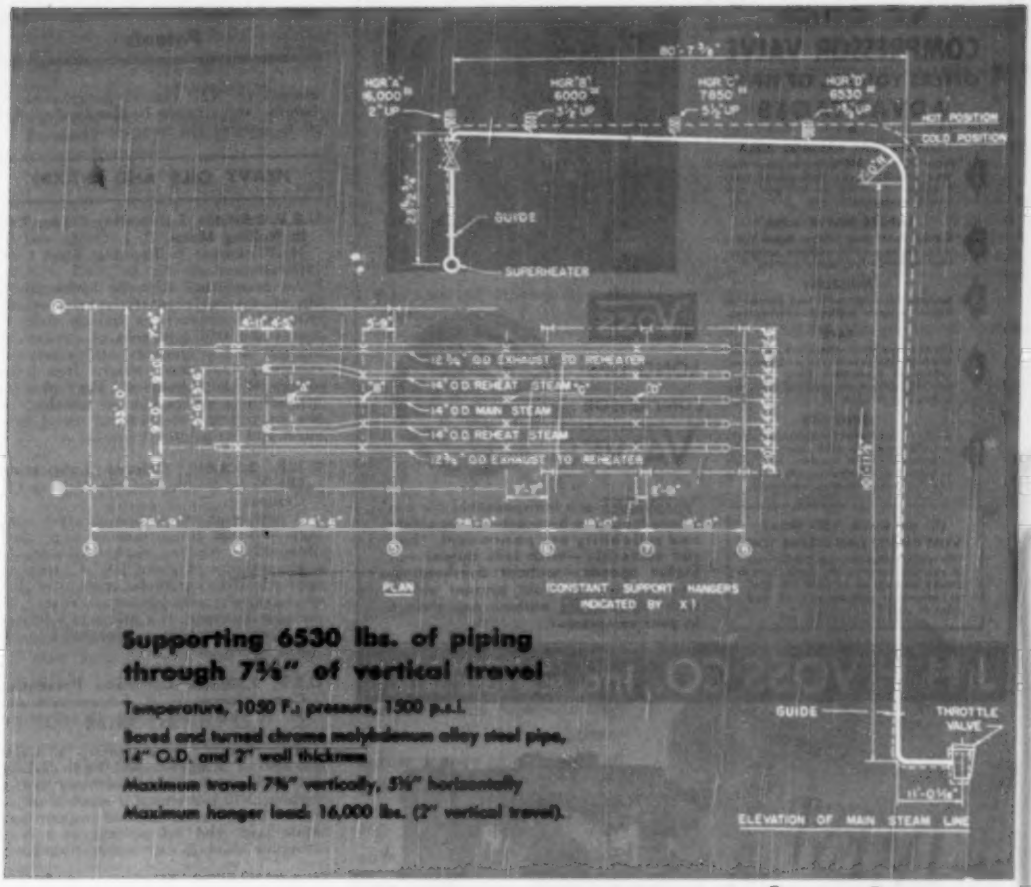
U.S.P. 2,510,096. Synthesis of Hydrocarbons and Oxygenated Hydrocarbons. W. G. Frankenburg and E. T. Layng to Hydrocarbon Research, Inc.

In a Fischer-Tropsch synthesis process, a continuous stream of gas-containing at least 15 percent CO_2, not more than 15 percent CO, not more than 1 percent of water vapor, and having a H_2:CO ratio of not less than 2.5:1 is passed in contact with an iron catalyst under suitable conditions. The net production of undesired by-products, such as CO_2 and light gaseous hydrocarbons, is materially suppressed in this process.

DESULFURIZATION

U.S.P. 2,508,817. Sweetening Light Hydrocarbon Oils. L. T. Devol and W. J. Ayers to Tide Water Associated Oil Company.

For sweetening sour hydrocarbon oils, particularly light petroleum oils suitable for motor oils but containing objectionable amounts of mercaptans, a small



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Temperature, 1050 F.; pressure, 1500 p.s.i.

Bored and turned chrome molybdenum alloy steel pipe, 14" O.D. and 2" wall thickness

Maximum travel: 7⅛" vertically, 5½" horizontally

Maximum hanger load: 16,000 lbs. (2" vertical travel).

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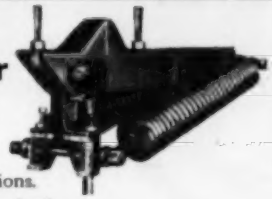

Provides constant support to piping subject to vertical movement — in all hot and cold positions. Maintains full safety factor in supporting high temperature, high pressure piping. Non-resonant and energy absorbing. Mass-produced from standard precision parts. Individually calibrated for each installation. Load-adjustment features incorporated into design. Models to meet entire range of load-travel specifications. Minimum headroom required.

Believing that a good piping job is too important to be jeopardized by improvised or inadequate pipe hangers, Grinnell has developed a complete line of stock hangers and supports for every piping need from a simple water pipe to a high pressure, high temperature steam line. Write for Catalog 10-D.

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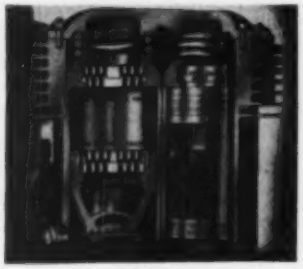

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From 20% to 100% increased valve area handles more and colder gas; a colder therefore denser gas costs less to compress.

2 LARGER VALVE AREA
Raises back and lowers head pressure, consequently reduces compression ratio—saving more power.

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Made to the highest standard of workmanship—on special machines—by craftsmen—in a modern and well equipped shop—designed to give long life under the severest conditions.

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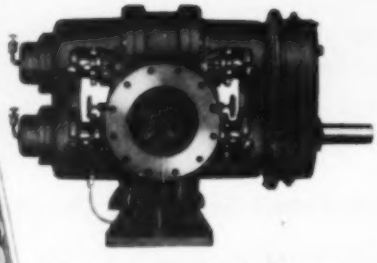

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KINNEY Rotary PUMPS

Patents

amount of NN' dialkyl paraphenylene diamine and oxygen is dissolved in the oil to oxidize the mercaptans.

HEAVY OILS AND WAXES

U.S.P. 2,508,016. Lubricating Oil for Use in Rolling Metal. P. J. Doyle and C. H. Flickinger to Republic Steel Corporation.

An unoxidized aliphatic hydrocarbon oil of special characteristics contains oxidized hydrocarbons having 6-18 C atoms and 0.01-2 percent of oxygen as organic acids, alcohols and esters of relatively high mol. weight free from aldehydes and ketones. The additive makes the hydrocarbon oil suitable for use in rolling or reducing metal into sheet and strip form.

U.S.P. 2,508,617. Colored Lubricating Oil. R. G. Mastin to Cities Service Oil Company.

A petroleum lubricating oil stock contains a small proportion of a product obtained by reacting phenylhydrazine at a temperature of about 100° C. with an approximately equimolar amount of dianisalacetone, anisalcinnimalacetone, or dicinnimalacetone, in acetic acid solution. The additive imparts a greenish fluorescence to the oil.

U.S.P. 2,509,786. Corrosion Preventive Compositions. K. F. Schiermeier and H. A. Poitz to Shell Development Company.

A rust inhibitor comprises a major amount of a light liquid hydrocarbon, 5-25 percent of an oxidized waxy hydrocarbon, 2-10 percent of a mixture of alkaline earth metal salts of organic sulfonic acid, and 1-5 percent of a non-aromatic alcohol, e.g., isobutyl alcohol.

U.S.P. 2,510,031. Method of Inhibiting Evolution of Hydrogen Sulfide from Sulfurized Oil Lubricants. B. Folda, Jr., to Socony-Vacuum Oil Company, Inc.

The evolution of H_2S from mineral oil lubricants compounded with sulfurized oils is inhibited by the addition of an oil-soluble soap of Pb, Cd, Co, Zn, Cr, Mn, Fe, Ni, or Co in certain proportions to the compounded lubricant after removal of free H_2S.

U.S.P. 2,510,816. Wax Composition for Coating Fruits. O. P. Greenstreet, San Diego, Calif.

A composition for coating fruits and vegetables comprises paraffin, a vegetable hard wax in an amount of 2 percent of the paraffin, and a sulfonated mineral oil.

ALKYLATION

U.S.P. 2,507,764. Conversion of Acid-Soluble Oils. P. H. Carnell to Phillips Petroleum Company.

An acid-soluble oil obtained from the acid phase of a process for the alkylation of an isoparaffin with an olefin in the presence of HF is alkylated with an isoparaffin in the presence of a fluid alkylation catalyst and in the absence of low-boiling olefins at a temperature of

150-400° F. under conditions such that a gasoline fraction comprising paraffins boiling in the gasoline range and a lubricating oil fraction are produced.

U.S.P. 2,507,765. Production of Alkyl Benzenes. F. M. Smith to Phillips Petroleum Company.

Details are claimed of a two-step process for catalytically producing high mol. weight alkyl benzenes from a mixture of benzene hydrocarbons and olefins with 7-18 C atoms.

U.S.P. 2,507,766. Production of Alkyl Benzenes. F. M. Smith and R. S. Hanmer to Phillips Petroleum Company.

The process of this patent is closely related to that of U.S.P. 2,507,765.

U.S.P. 2,509,028. Method of Producing Gasoline by Alkylation and Reforming. A. J. Abrams and C. S. Kuhn, Jr., to Socony-Vacuum Oil Company, Inc.

A relatively wide boiling mixture of high quality gasoline is produced from a relatively narrow boiling alkylate produced by reacting light isoparaffins with olefins in the presence of HF. The alkylation reaction mixture which comprises relatively narrow boiling alkylate gasoline, normally gaseous hydrocarbons, and HF is fractionated and reformed by distilling off the normally gaseous hydrocarbons and further contacting the alkylate with the HF until substantial reforming of the alkylate is effected.

PETROCHEMICALS

U.S.P. 2,507,502. Oxygen Carrier for the Oxidation of Gaseous Hydrocarbons. E. S. Corner and C. S. Lynch to Standard Oil Development Company.

An oxygen carrier adapted for the oxidation of a normally gaseous hydrocarbon consists of a mixture of 97 percent titania and 3 percent of an oxide of Fe, Mn, Cr, Ni, or W.

U.S.P. 2,507,527. Chemical Process. R. Johnson to Koppers Company, Inc.

Ethyl naphthalene in the liquid state is reacted with oxygen in the presence of an oxidation catalyst at a temperature below that at which dehydration of methyl and naphthyl carbinol occurs. The resulting mixture of this compound and methyl naphthyl ketone is reacted in the liquid state with hydrogen in the presence of cupric chromite at a temperature of 100-175° C. Methyl naphthyl carbinol is obtained as the main reaction product.

U.S.P. 2,507,568. Telomers of Mono-olefins and Saturated Halogenated Carboxylic Acids, Esters and Anhydrides. W. E. Hanford and R. M. Joyce to E. I. du Pont de Nemours & Company.

A reaction mass comprising a mono-olefin of 2-4 C atoms and a saturated halogenated lower aliphatic acid, or an anhydride or lower alkyl ester thereof, is subjected at a temperature of 60-150° C. and increased pressure to the action of a peroxy polymerization catalyst. A product is obtained which contains a plurality of olefin molecules for each molecule of the halogenated compound.

U.S.P. 2,507,731. Process of Reacting Phosphorus Sulfide and Olefinic Hydrocarbon. L. W. Mixon and E. N. Roberts to Standard Oil Company (Indiana).

An olefinic hydrocarbon with a mol weight of at least 150 is reacted with 1-50 percent of a phosphorus sulfide in the presence of 5-100 percent by weight (based on the olefin) of an aromatic hydrocarbon at a temperature of 100-500° F. The resultant product is neutralized. It is resistant to emulsification and is effective as a detergent-type additive.

U.S.P. 2,509,160. Making Hexachlorocyclopentadiene. E. T. McBee and C. F. Baranauckas to Purdue Research Foundation.

Aliphatic hydrocarbons with at least 5 C atoms in the molecule and at least 4 C atoms in the longest chain, or alicyclic hydrocarbons with 5 C atoms in the ring, are heated with chlorine in an amount at least equal to that theoretically required to produce hexachlorocyclopentadiene at a temperature of 350-550° C. Hexachlorocyclopentadiene is produced.

U.S.P. 2,509,855. Conversion of Durene

Patents

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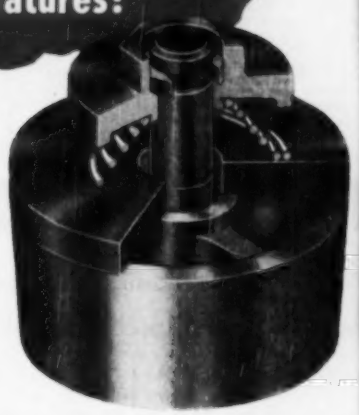

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EACH PART HIGHLY EFFICIENT!

1. Hard, bronze alloy 3-web seat is cast with center guide as integral part.
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*For higher temperatures up to 950°F, we recommend our all-stainless steel valve and seat of the same design.

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Patents

to Carboxylic Acids. L. K. Beach to Standard Oil Development Company.

A gasiform mixture of 0.01-1 mol percent of 1, 2, 4, 5-tetramethyl benzene vapor per 100 mols of air is contacted with a V_2O_5 catalyst promoted by K_2SO_4 at a temperature of 440-450° C. and a contact time of 0.1-1 second. 1, 2, 4, 5-tetracarboxy benzene is produced.

U.S.P. 2,509,859. Nitriles from Butadiene and Hydrogen Cyanide. D. D. Coffman, L. F. Salisbury, and N. D. Scott to E. I. du Pont de Nemours & Company.

Butadiene is contacted with HCN in the presence of a cuprous halide catalyst. A butadiene-hydrogen cyanide adduct is obtained.

U.S.P. 2,509,878. Preparation of Aldehydes. J. J. Owen to Standard Oil Development Company.

A relatively small amount of a cobalt soap is dissolved in a liquid olefin and a small amount of alcohol is added to retard gelatination. The resulting solution is continuously charged to a reaction zone simultaneously with a CO/H_2 mixture at a temperature of 200-400° F. and a pressure of 100-300 atm. Aldehydes are formed.

U.S.P. 2,509,938. Process for Preparing Fused Cyclic Derivatives of Thiophene. J. A. Patterson and C. H. Culnane to The Texas Company.

A cyclic compound of the general formula R_1-R_2 wherein R_1 and R_2 represent cyclic nuclei containing a hydrogen-substituted C atom adjacent to the intercyclic bond, e.g., diphenyl, is reacted with H_2S in the vapor phase in the presence of a solid particulate catalyst, e.g. an oxide or sulfide of a metal of group VI and a surface-active material, at a temperature of at least 700° F. Fused cyclic thiophene derivatives are obtained.

U.S.P. 2,510,105. Process for the Manufactuer of Organic Acids. D. G. Hedberg, Jr., to Eastman Kodak Company.

Details are claimed of a process for producing lower aliphatic acids and ketones from olefin, CO, and water in the presence of an aqueous cobalt-containing catalyst liquid.

U.S.P. 2,510,134. Method for Producing Mono-isopropyl Quinoline. S. F. Orochena and W. M. Kutz to Koppers Company, Inc.

Quinoline is reacted with aqueous HCl and propylene in the presence of an alumina-silica catalyst. The neutralized reaction product is extracted with a solvent, and the resulting mono-isopropyl quinoline is separated from the extracts by distillation.

U.S.P. 2,510,921. Preparation of Organic Sulfides. L. F. Bauer to California Research Corporation.

An olefin is reacted with H_2S in the presence of an $AlCl_3$ catalyst. The mol ratio of this catalyst to the monosulfide formed shall be equal to at least one, in order to secure a product containing predominantly monosulfides.

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Write Department 16

World Petroleum Congress Programs Dignitaries

A committee of honor, being formed in connection with the Third World Congress to be held next year in the Netherlands, will include a number of cabinet ministers among whom are the Netherlands ministers for foreign affairs, economic affairs and education, and arts and science. The Congress will meet in the Kurhaus, Scheveningen, May 28-June 6, 1951.

Four speakers presenting papers are Professor J. J. Broeze, Royal-Dutch Shell Laboratory, Delft, "Future Aspects of the Applications of Fuels and Lubricants"; Professor C. Hugel, Institut Francais du Petrole, "Recent Progress in the Chemistry of Petroleum and Its Derivatives"; Dr. C. M. Lees, Anglo-Iranian Petroleum Company, Ltd., London, "The Oilfields of the Middle East"; and E. V. Murphree, president of Standard Oil Development Company, New York, "Benefits from Research to the Petroleum Industry."

Members of the national Committee for the U.S. are Earl Bartholomew, general manager, research labs, Ethyl Corporation, representing the Society of Automotive Engineers; J. E. Brantly, president, representing Drilling and Exploration Company, Inc.; F. S. Clulow, vice president, representing Shell Oil Company; Dr. W. F. Faragher, Houdry Process Corporation; Dr. Paul D. Foote, executive vice president, Gulf Research and Development Company; A. P. Frame, president, Cities Service Research and Development Company; J. R. Keith, manager of research and development of Caltex-Bapco Group; Dr. C. G. Kirkbride, Houdry Process Corporation, representing the American Institute of Chemical Engineers; E. V. Murphree, president, Standard Oil Development Company; Dr. L. L. Nettleton, Gravity Meter Exploration Company, representing the Society of Exploration Geophysicists; C. E. Reistle, Jr., director of production for Humble Oil & Refining Company, representing the American Insitute of Mining & Metallurgical Engineers; and M. E. Spaght, president, Shell Development Company.

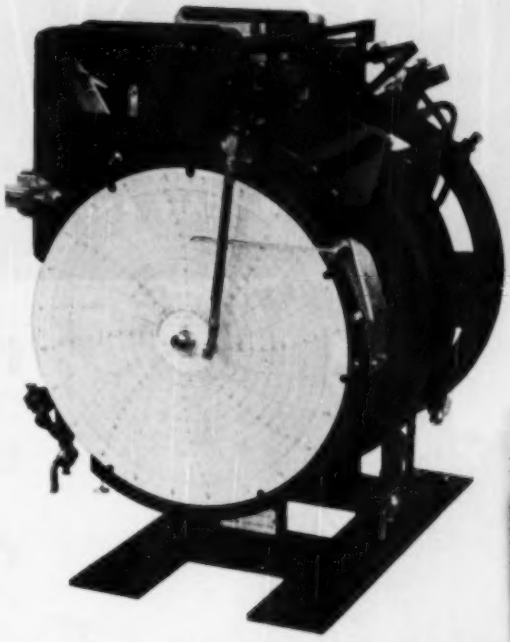
Instrument Society Plans 1951 Meet in Houston

The 1951 conference and national exhibit of the Instrument Society of America will be held September 10-14 at the Coliseum in Houston. On a national scale the following societies are cooperating in convention plans; the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers, The American Institute of Physics, The Instruments and Measurements Committee of the American Institute of Electrical Engineers, the Institute of Radio Engineers, the National Telemetering Forum, and The Scientific Apparatus Makers Association.

Sinclair Names Chemist

Sinclair Refining Company has appointed N. J. Gothard, chief chemist with headquarters at Harvey, Ill. Gothard, who joined Sinclair Refining in 1919 as a chemist at East Chicago, was formerly assistant chief chemist. He holds a degree in chemistry from the University of Wisconsin.

four typical flow-metering services of Hagan Ring Balance Dual Meters



One common type of Ring Balance Dual Meter is the Hagan Boiler Meter, shown above. Low pressure ring measures air flow, high pressure ring measures steam flow.

The Hagan Ring Balance Dual Ring Flow Meter is in reality two meters, recording on a single chart, and housed in a single standard size meter case. This gives the advantage, not only of saving space, but of producing several related records on a single chart.

Both ring assemblies may be high differential, both may be low differential, or one may be high and the other low differential. Static pressures can be anything up to 15,000 psi. The recording mechanisms may operate independently, or they may be linked together to produce a combined record.

Four applications typical of flow measurements which are possible with this versatile meter are the following:

1. Measurement of Two Independent Flows—A direct record of the relation between two rates of flow may be shown on a single chart, as, for example, steam flow and air flow, or gas flow and air flow.

2. Independent Measurement of Two Flows, with Automatic Totalization—This may be used to produce records of flow from each of two boiler outlets or to a process having two inlets, with a third record and integration of the total flow.

3. Independent Measurement of Two Flows, with Automatic Subtraction—In the case of a split flow, measurements may be made of the main flow and of the flow through one branch, with records of these and of the difference, which represents the flow through a second branch. Any two of the flows may also be integrated automatically.

4. Automatic Correction of Flow Measurements on Basis of Liquid Gravity or Gas Density—With one element of the Dual Meter measuring flow and the second element measuring gravity of a liquid or density of a gas, records may be produced of the corrected and uncorrected flow rates and of gravity or density measurement, with automatic integration of either flow rate. Correction for temperature and pressure factors also may be made automatically.

For more detailed information, describe the particular application in which you are interested, or fill in the coupon. Mail to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
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Company _____

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PB-8

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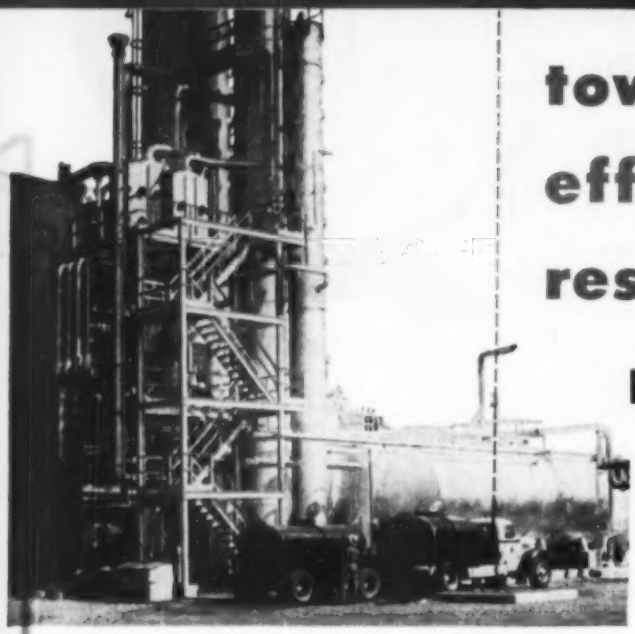

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PACKED TOWERS, bubble towers, towers with grids or baffles—Dowell's tested Chemical Scale Removal Service has proven effective in cleaning all types. Accumulated scale and sludge have been removed rapidly and designed efficiency restored with a minimum of expensive outage time and inconvenience.

Dowell engineers select the proper liquid solvent designed to dissolve and disintegrate the deposit. Using equipment designed by Dowell, the solvents are pumped into the tower, filling it to capacity . . . or are pumped in at the top of the tower and allowed to flow down over the trays. Finally, the spent solvent is flushed out and the tower is ready to be put back into operation, usually within 24 hours.

Dowell service engineers do not require special scaffolding or the dismantling of the tower. Specially designed truck-mounted tanks, pumps, heaters, mixers, and control equipment necessary to do the job properly are brought right into your plant.

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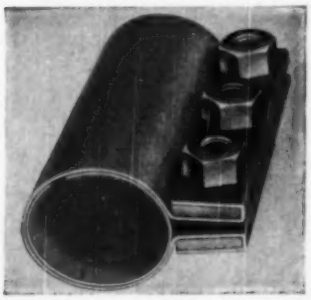
NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages use the coupon below, circling the number shown for each item desired.

Air Line Pressure Pump

1 The GS No. 17 pump of General Scientific Equipment Company is fitted with a safety valve for air line pressure and a hold down clamp to secure the pump into the container, together with 25 feet ¾ inch air hose with male or female coupling and chuck attached. Lead tubes are suitable for sulfuric, hydrochloric, hydrofluoric acids and others. Saran plastic tubes are recommended where the pump is to be used in nitric, muriatic, citric, phosphoric, acetic, bleaches, peroxide and others.

Pipe Couplings



2 Pipe couplings in the standard zinc coated steel line and also aluminum are available in all sizes to 8 inches from the manufacturer, Morris Coupling and Clamp Company. Uses are for permanently joining plain end or threaded pipe or a combination of the two. The coupling is applicable with a socket or crescent wrench. Rubber base gaskets are furnished as standard equipment, but gaskets of cork, fibre glass, and neoprene can also be had. The compression band type coupling serves to hold the entire surface of the joint in compression.

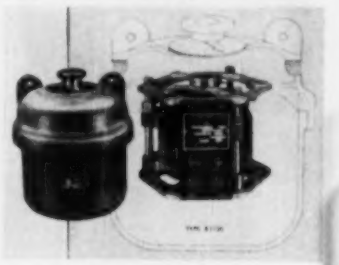
Refractories Materials

3 A refractory materials catalog and engineering data book entitled "Better Refractories," issued by Mexico Refractories Company, includes application data, properties of refractory materials, wall temperature gradients, etc. Illustrations show products, standard and special shapes of refractory wall materials and cements, plastics, and coatings.

Boiler Facilities

4 Fitzgibbons Boiler Company, Inc., has published a bulletin describing the manufacturing facilities of their plate products division. Included are equipment, testing facilities, and illustrations on fabrications of steel pressure vessels.

Powerstat



5 The Superior Electric Company has added to its line of variable transformers the explosion-proof Powerstat with Underwriters' approval for Class 1, Group D service. The models consist of avariable transformer totally enclosed in a case for withstanding internal gas or vapor explosions. The case is designed to prevent the ignition by internal spark, flash or explosion of

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be readily available.

PETROLEUM REFINER
BOX 2608, HOUSTON 1, TEXAS

Please have manufacturers send me, without obligation, additional information about items from August, 1950, New Equipment Section whose numbers are circled below:

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	32	33	34	35
36	37	38				

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PLEASE PRINT OR TYPE YOUR COMPLETE MAILING ADDRESS

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 182.)

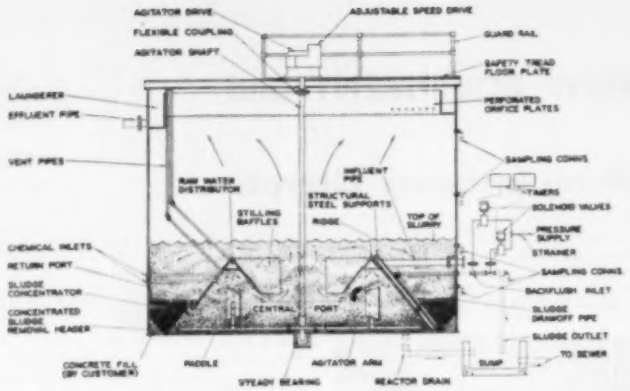
the gas or vapor surrounding the enclosure. Types are available in 115 and 230 volt ratings for single phase operation. Type X-1126, shown herewith, is rated 115 volts, 50/60 cycles, 1 phase input with 0-135 volts, 12 amperes output.

Self Priming Pump

6 A new line of self-priming centrifugal pumps containing no valves is offered by Goulds Pumps, Inc. in sizes from ½ to 5 hp., open and closed impellers. Capacities up to 120 gpm. and heads to 135 feet are dependent on capacity. Suction lifts up to 25 feet. Other advantages claimed are no large priming reservoir, and no recirculation of water during pumping stage. Bulletin 636.1.

Stud Welding

7 Applications of stud welding, described in a folder of Nelson Stud Welding Division of Morton Gregory Corporation, include installations of roofing, siding, windows, and decorative panels; insulation, electrical equipment, and various types of reinforcing for concrete and gunite.



Sludge Contact Reactors

8 A new sludge contact reactor of Cochrane Corporation is designed for clarification of surface water for straining and cooling; lime or lime-soda softening; coagulation and reduction of alkalinity; removal of fluorides; clarification and de-alkalization; iron and manganese removal; separation of fibre stock and filter from white water; waste water treatment to reduce pollution of streams.

Flange and Coupling Selector

9 A slide rule type flange and coupling selector designed by Nooter Corporation, presents at once all pertinent data for 150-pound and 300-pound ASA standard as well as for standard, extra heavy, 3000 and 6000-pound couplings. A table also shows wall thicknesses of standard, extra heavy and double heavy pipe as well as for all schedules of pipe from 10 through 160.

Strainers and Separators

10 Strainers, suction strainers, multi-flow separators, and receiver-separators are described in "ADSCO Strainers and Separators," Bulletin No. R-46-50A, of American District Steam Company. Included are dimensions, weights and list prices of the entire line; data for the selection of proper type and capacity; and engineering information on flange dimensions and service pressure ratings.

Dial Thermometer

11 Palmer Thermometers, Inc.'s newly developed 4½-inch dial thermometer, featuring "greater accuracy and readability," is mercury-actuated and fully compensated by Invar compensation. A flexible stem permits the thermometer to be installed at any angle. The case can be rotated to any readable position. Bulletin 50-128 contains standard ranges and standard stem lengths. Accessories include union connection, union flange, and separable sockets of brass, steel, 303 or 316 stainless steel. Other features include heavy steel back case, bonderized baked enamel finish, and heavy all glass front. It is also said to be dust, vapor and water proof.

Air Traps

12 Armstrong Machine Works Bulletin covers selection and installation of air traps for automatic drainage of moisture from compressed air intercoolers, after-coolers, receivers, separators, and drip points. Illustrations show air trap models, their applications and working principle. Also included are physical data.

Hand Pipe Threader

13 A new hand threading tool for use with "Karbate" impervious graphite pipe has been announced

Need More Data?

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side.

Prompt action is suggested so that data will be readily available.

Kellogg's unique devices aid in producing special types of process piping

NOT only does Kellogg fabricate virtually any type of process piping from carbon steel to alloy and alloy-lined, but it also rolls, welds and forms it from plate in sizes beyond those readily available from tube mills.

When it comes to fabricating and bending, size is limited only by what can be shipped. One-piece bends up to 96-inch diameter are made on an exclusive bender. Larger diameter bends are made from welded segments. Small diameters are handled on regular bending tables and fabricated into sub-assemblies to minimize field labor. Another unique machine produces quality corrugated pipe for expansion bends.

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New Equipment

(For additional information or literature check item numbers on mailing coupon, page 182.)

by National Carbon Division, Union Carbide and Carbon Corporation. The new tool, which eliminates need for an expensive lathe operation, makes it possible to cut, thread, and install pipe right on the job.

Curtain Wall Construction

14 A booklet of Allegheny Ludlum Steel Corporation reports on proposed methods of curtain wall construction in which prefabricated sections of stainless steel sheathing backed by insulating material would replace masonry or other materials in the construction of exterior walls of multi-story office and other buildings. Scale drawings show existing and planned types of stainless steel curtain walls with specific attention given to such details as facings, insulation, joints, vents, window sections, and shapes and textures. Also discussed are building codes and tests affecting stainless steel curtain wall construction and what is being done to meet them.

Self-Priming Pumps

15 Roto-Prime pumps, single-stage, single-action volute type, having no priming reservoir, are announced by Gilbert & Barker Mfg. Company as a new line of self-priming centrifugal pumps. Available in capacities from 50 to 450 gpm., the pumps will handle petroleum and chemical products in tank car and transport loading or unloading, as well as for loading and barrel-filling purposes. They are furnished complete with a base, electric motor, coupling, built-in check valve, and mechanical seal.

Corrosive Equipment Repair

16 Bulletin C-8 of Carboline Company describes the use of corrosion resisting cements to repair cracked, corroded and broken pipe, pumps, valves, and other mechanical equipment in corrosive service. The synthetic resin cements used are resistant to virtually all acids, solvents and alkalis, up to temperatures of 325° F. The only common acids which cannot be handled by these repair cements are sulfuric acid above 90 percent concentration, and nitric and chromic acids. When set, the repair cements are hard, resistant to abrasion and can be machined if necessary.

Safety Hat

17 A 12-ounce airdraft grade aluminum alloy safety hat of E. D. Bullard Company has ribbed designed rim with resilient crown to absorb impact of a falling object. The inner hat assembly is designed to absorb shock with its full-floating, six-point suspension hammock. Headbands and hammocks are adjustable to fit all head shapes and sizes. The entire assembly can be replaced without tools with slide action wedge type fasteners. The crown is natural aluminum color, with a nonglare finish.

Spiral Plastic Packing

18 A vulcanized tape-back is featured in Crane Packing Company's super-seal spiral plastic packing which can be twisted down to small

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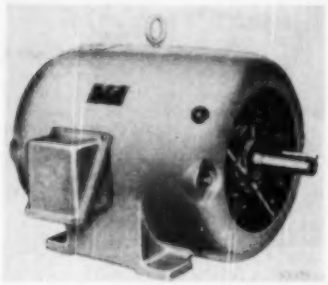
shaft sizes and then cut into rings without breakage. Packings are furnished in six styles. Other features claimed are great resilience and homogeneity. They are said not to harden at elevated temperatures and need not be removed as wear occurs. Composition is of asbestos, anti-frictional metal particles, flake graphite, and special binders.

Frame Motors



19 Wagner Electric Corporation has developed a full line of cast iron frame totally enclosed fan-cooled motors, which are available in ratings from 5 through 250 hp. in both standard (type EP) and explosion-proof (type JP) designs. Construction details include cast iron frame, endplates, blower shield, and conduit box; corrosion resistant blower; sealed leads; cartridge type ball bearings; protected laminations; special varnish treatment; cast aluminum rotor; drain plugs; corrosion resistant nameplate.

Monobed Deionization

20 "Amberlite Monobed Deionization" of Resinous Products Division, Rohm & Haas Company, offers a miniature textbook on history, behavior, present performance and potential uses of the Monobed ion exchange systems in industry. Reactions of the various combinations of exchangers are included. Operating costs, equipment costs, quality of product derived, rinse requirements and other properties are explained as they apply to the complete or partial single-step removal of ionized solids from solution. Design, operation, of Monobed equipment, and more than 80 fields of possible applications are listed. A final table shows the nomenclature, chemical behavior and typical uses of each of six systems.

Couplings and Fittings

21 Photographs and details on each type coupling and fitting together with specifications, general and maximum pressure recommendations and a description of threads are included in a catalog section of hose couplings and fittings of The B. F. Goodrich Company. Products mentioned are common couplings; short and long shank; combination nipples, special suction hose couplings, including the quick action type, interlocking high pressure couplings; hydraulic hose couplings and hose adapter unions; Permalock couplings; garden hose couplings; Flexseal hose joint; Bar-Way reattachable; fire hose couplings; pipe, inserted, built-on and scored nipples, flanges, hose clamps and hose menders.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 183.)

Tachometer Generator

22 A new Type E tachometer generator developed by Weston Electrical Instrument Corporation, for use in explosive atmospheres, is available as an a.c. or d.c. generator. Approved by Underwriters' Laboratories, Inc., for Class I, Group D and Class II, Groups F and G. The housing measures approximately 10¼ inches overall and 4½ inches in diameter. Its ¾ inch diameter stainless steel shaft, with a mechanical flat for a gear or coupling, extends 1½ inches beyond the bearing support. Electrical connection is made in a terminal box tapped to take standard ½-inch conduit.

Process Pumps

23 Bulletin W-341-B14 on type HM process pumps of Worthington Pump and Machinery Corporation, describes materials of standardized construction and interchangeability. Features are also listed. Cross-section drawings show the vertically-split, single stage, volute centrifugal process pump which

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New Equipment

(For additional information or literature check item numbers on mailing coupon, page 183.)

is capable of pressures up to 450 psi. and temperatures up to 500° F. The pump will take corrosive and non-corrosive liquids. Type HM can be obtained in cast iron, bronze, stainless steel, carbon steel and Worthite. Mechanical seals are optional.

Stainless Hose

24 Corrosion resistant flexible stainless steel hose, manufactured by Chicago Metal Hose Corporation, is claimed to withstand high temperatures and pressures. It is used for conveying corrosive or searching liquids and gases where motion is required. Extreme flexibility gives hose the ability to withstand extreme cycles of vibration, flexation and variplane motions. Closed corrugation pitch and open corrugation pitch hose are available. The hose is fabricated in sizes from 5/16 through 6" I.D. in one or multiple ply construction and is available with helical or annular corrugations, with or without braid covering, depending upon pressure and other factors of service use. Wall thicknesses are from .003 in single ply to .030 inches in multiple ply construction; working pressures to 2000 psi. Standard pipe fittings or fittings to special requirement may be attached by silver brazing or welding.

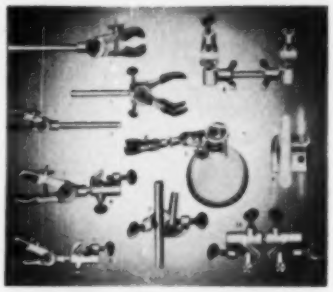
Centrifugal Pumps

25 Bulletin W-306-B1 describing Monobloc centrifugal pumps, types DN, DNE, DDN, DDNE and DHN, single and two stage, size 1 to 5, is announced by Worthington Pump and Machinery Corporation. Included are specifications, motor data and materials for construction. A section on how to select a cold water pump contains rating curves for 5 and 60 cycle speeds at 1500, 1800, 3000, and 3600 rpm. These pumps are a companion line to the type CN frame mounted units, and liquid ends and ratings of the two lines are interchangeable.

Heavy Duty Motors

26 Design, construction, selection, ordering information, and frame dimensions for Type "T" heavy duty, constant and adjustable speed motors are given in a bulletin of Reliance Electric & Engineering Company. Available in drip-proof, splash-proof, totally-enclosed, explosion-proof, blower-ventilated land gearmotor construction, these motors are explained as to mechanical features and electrical characteristics. Users of d.c. motors from ¾ to 1000 hp. are said to find the bulletin helpful.

Alumaloy Clamps



27 A brand new design is incorporated in Laboratory Industries, Inc.'s new line of aluminum alloy clamps marketed under the trade name "Alumaloy." Advantages claimed are tensile strength of 45,000 psi.; nonporous surfaces; high melting point of 1100° F. and safety factor of 400° F.; corrosion resistance; claw-like jaws; adjustable rod clamp, swivel clamp holder, and all position clamp holder; individual boxing; larger pivot pins; and solid extension rods. Brochure available.

Flame Sprayed Coatings

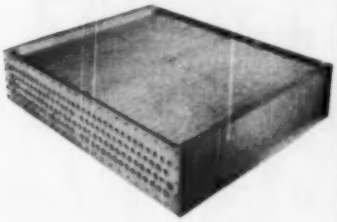
28 A method of flame spraying polyethylene coatings on steel tanks, tank cars, and processing equipment, and perfected by Houghton Laboratories, uses no solvents, applying coatings in thicknesses from 1/32 to ¼ inch. Deposited on the tank in melted form, the polyethylene sets up to a

tough, non-porous film which is resistant to many chemicals and corrosive materials. It is said to be an odorless, taste-fee, and completely non-toxic coating.

Ground Clamp

29 The Lincoln Electric Company's new 1½ pound ground clamp is designed to provide solid ground connection for welding jobs where welding currents do not average over 300 amperes. The jaw has a spread of 2½ inches. A heavy direct acting spring gives a positive, slip-proof connection with the work. Frame is of pressed steel construction with jaws being a special steel and copper alloy, "Lincalloy" which is said to be both highly conductive and highly resistant to wear. The GC-3 does not replace the Lincoln heavy duty GC-5 which has a capacity of 500 amperes.

Heat Exchanger



30 For cooling large enclosed motors, Elliott Company has introduced a finned tube air-to-air heat exchanger, comprising a single rectangular unit. The exchanger is located at the top of the welded-steel motor frame. A fan draws cooling air from outside the motor, through the tubes, and out the front of the motor enclosure. Air within the motor is passed over the finned tubes, cooled, and recirculated. Ratings are 2-pole at 300 to 4000 h.p. and for lower speeds from 14-pole, 50 h.p. to 4-pole, 3000 h.p.

Transformer Welders

31 A new line of a.c. transformer welders in which welding heat adjustment is accomplished electrically through an a.c.-d.c. reactor is announced by Hobart Brothers Company. There are no electrical or mechanical connections between the power lines and welding cables. These sets can be furnished for operation on single phase, 60 cycle supply current either 220/440 dual voltage, 440/550 or 220/440/550 volts. They can also be furnished with 50

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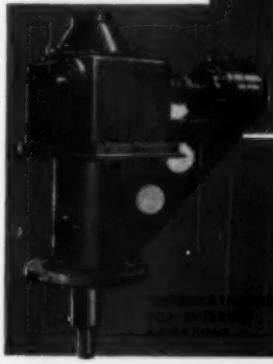


Call on INTERNATIONAL'S vast experience for assistance in solving your Mixing and Blending problems. Our Engineering staff is at your service — write for catalogs and complete information on Top Entering, Side Entrance and Portable Mixers, which are free for the asking, and no obligation, of course.

INTERNATIONAL ENGINEERING, Inc.
DAYTON, OHIO

YOU can STOP RUST . . . PREVENT RUST . . . on *all* your rustable metal surfaces with RUST-OLEUM. Every day, rust eats away on your metal tanks, pipelines, drilling and pumping machinery, metal buildings, roofs and fences. Yet, rust *can* be stopped and protection given economically with RUST-OLEUM.

For more than a quarter of a century RUST-OLEUM has been *proved* under severe conditions of weather, fumes, salt air, salt spray, and other rust producing conditions. Railroads, shipyards, builders, refiners . . . nationally known users* in almost every field of industry . . . have found RUST-OLEUM the economical way to stop rust and prevent further rust. Architects, builders, engineers, maintenance men now specify RUST-OLEUM for primer, "shop coat", and finish coats.

RUST-OLEUM adds extra life to metal buildings, equipment and other metal surfaces and can be applied over already rusted surfaces without extensive surface preparation. Yet, RUST-OLEUM costs no more than most quality materials.

RUST-OLEUM not only protects—it beautifies as well! RUST-OLEUM is available in a large selection of colors including aluminum and white. It spreads evenly . . . and dries free of brush-marks in 4 to 12 hours, depending on conditions, to a tough, pliable film that protects against rust.

Be sure you get *only* genuine RUST-OLEUM for positive protection against rust! Specify *RUST-OLEUM* to your contractor or architect on any new construction, remodeling or maintenance work.

RUST-OLEUM is stocked and sold by leading industrial distributors in all principal cities of the United States and Canada. See Sweets for complete catalog and nearest source of supply, or write us direct for complete information.

*Names on request

RUST-OLEUM CORPORATION

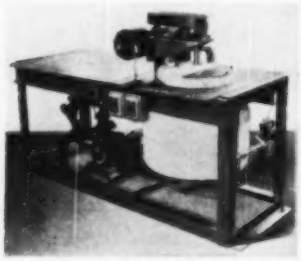
2554 Oakton Street • Evanston, Illinois

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 183.)

cycles and ampere sizes of 200, 300, 400, and 500 with stationary or portable mountings. The transformer has conventional primary and secondary windings.

Batch Kettle



32 An all-steel table frame with built-in motors to drive scraper-agitator and pump for re-circulating or removing contents are featured in a new lab kettle for lab or small batch use offered by Chaffee Design and Manufacturing Company. Thermostatically controlled gas heat operates up to 400-500° F. The scraper-agitator in the kettle is driven and controlled by a variable speed motor. Under the table top is a pump that removes the contents from the bottom of the kettle through a flush valve at temperatures up to 500° F., discharging the batch into a manifold and then to open pans for slow cooling. The batch can also be recirculated back to the top of the kettle, through a strainer, for cleaning or "grease working," through a relief valve, or to other extra equipment such as a flaker.

Control Drive

33 A completely enclosed air-operated control drive which can be "tuned" to the requirements of a special application has been developed by Bailey Meter Company. With a double acting air cylinder with rigid supporting stand and enclosure, a positioning relay, and a manual operating wheel or lever, the drive incorporates a cam

whose shape determines the relation of control drive position to control loading pressure. Three cams are included with each drive and may be used interchangeably to obtain positions which are proportional to the first power (straight line), square, or square root of the control loading pressure. The drives are available in two sizes: 6 by 8-inch cylinder (6-inch bore and 8-inch stroke) for torque requirements of 280 feet per pound to 400 feet per pound; and 8 by 16-inch cylinder (8-inch bore and 16-inch stroke) for requirements up to 1500 feet per pound.

Fittings

34 The Kennedy Valve Mfg. Company Bulletin 104 describes the complete line of cast iron, malleable and bronze fittings including additions of cast-iron screwed, sprinkler, and extra-heavy malleable fittings.

Metal Hose Selection

35 Industrial metal hose tubing and fittings for conveying solids, fluids or gases at elevated pressures and temperatures are described in Universal Metal Hose Company's No. U-101 catalog. Typical applications and specifications for each hose classification are listed. Cross-section photos give close-ups of construction detail. Described are square-locked flexible tubing, interlocked flexible hose, seamless flexible hose, diesel engine exhaust hose, hose assemblies, and couplings. Diameters range from ⅛ to 30 inches in standard metals, including stainless steel, monel and other new alloys.

Multistage Turbine

36 Bulletin S-146 describing a multistage turbine of Terry Steam Turbine Company contains photographs and drawings, data on casing, lagging, blades, nozzles, wheels, shafts, diaphragms, bearings, interstage and end glands, governors, synchronizers, governor valves, steam strainers, nozzle control valves, sliding feet, auxiliary oil pumps, and lubrication.

Extraction Equipment

37 "The Practical Way of Solvent Extraction," Bulletin No. 12 of Otto H. York Company, Inc., describes the Patented York-Scheibel liquid-liquid extraction equipment. A comparison between fractional liquid extraction and fractional distillation is made, and specific liquid-liquid extraction applications in the process industry are listed.

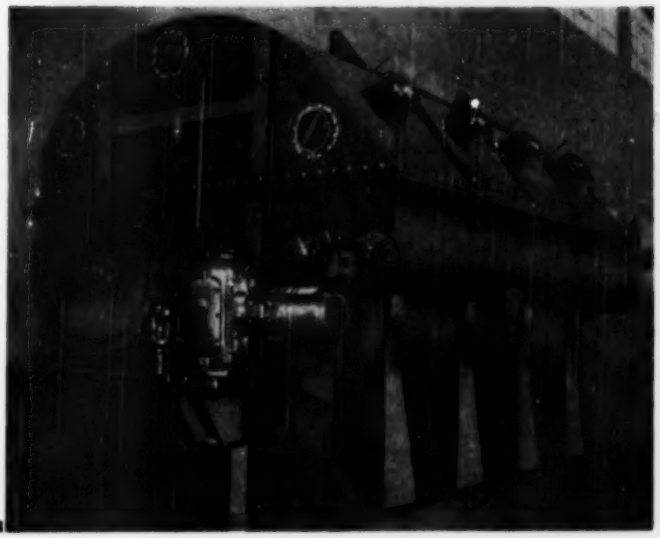
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 183.)

Earthquake Safety Switch

38 A new Sentry automatic earthquake or explosion operated electric switch of McRae Valve Corporation is designed automatically to shut off electric equipment in the event of a severe explosion or earth shock. Operated on the "Tri-Filar" principle, the switch is frequently installed as one unit of a multiple set-up of safety devices. The switch can be arranged in sequence with fire operated switches and opening and closing valves. Thus, in the event of fire, earthquake, explosion, or other emergency, machinery can be cut off, valves on gas or fuel lines entering the building shut off, and other emergency valves opened to sprinkle, fog, or flood dangerous areas.

GB = Guaranteed Buy in dewaxing filters



G-B has designed and manufactured over 150 filters for the petroleum industry for dewaxing oil and deoiling wax. This background of design and manufacturing experience is your guarantee of proven performance and

Low Installed Cost
Low Maintenance Cost
Maximum Time on Stream

• **Complete information on request.**

GOSLIN-BIRMINGHAM MANUFACTURING CO., INC.
BIRMINGHAM, ALABAMA
NEW YORK: 350 Madison Ave.

BOOKS

Instrument Flow Plan Symbols

Instrumentation Flow Plan Symbols. Instrument Society of America, 921 Ridge Avenue, Pittsburgh 12. Prices: 1-20 copies, $1 each; 21-50, 50 cents each; 51-100, 30 cents each; 101 or more, 25 cents each.

ISA tentative recommended practice RP5.1, "Instrumentation Flow Plan Symbols," gives a system of symbols and identifications for industrial process instrumentation equipment and designates, with identification, such equipment on flow plans and in other requirements. The system identifies instrumentation for recording in specifications, listings, requisition, and order sheets; indicates item on piping and other construction drawings; for tagging or equipment; and use in technical and trade literature and drawings.

Report was prepared by the subcommittee on instrumentation flow plan symbols of the main recommended practices committee.

Southeastern Oil Samples

Analyses of Crude Oils from Some Fields of Southeastern United States (Investigations 4687), O. C. Blade and E. L. Garton, Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13. Free.

Analyses of 51 samples of crude petroleum from six southeastern states—Alabama, Florida, Kentucky, Mississippi, Tennessee and Virginia—are given in a report by the Bureau of Mines.

This study was conducted under the general supervision of R. A. Cattell, chief of the petroleum and natural gas branch, and H. C. Fowler, supervising engineer of the petroleum experiment station at Bartlesville, Okla.

Wide variation is shown in the physical and chemical properties of the samples, according to the report which contains important data on the sources and properties of the crudes analyzed, as well as information regarding the areas represented, year of discovery of each field, production in 1948, and total reported production by field and state through 1948. It also includes a list and bibliography of analyses of crude oils from this region dating back to 1921.

Chemical Economics Handbook Offers Data Sheets and Graphs

Chemical Economics Handbook, Stanford Research Institute, Stanford, Calif.

Stanford Research Institute has launched a new type of encyclopedic information service with its Chemical Economics Handbook, designed for executives and others planning company economic policies. The institute's department of business and industrial economics will furnish subscribers data sheets containing graphs of special chemical economic relationships covering consumption and production data for a wide variety of chemical products. Production, sales, consumption patterns, price histories, and exports and imports of chemicals and related products are shown.

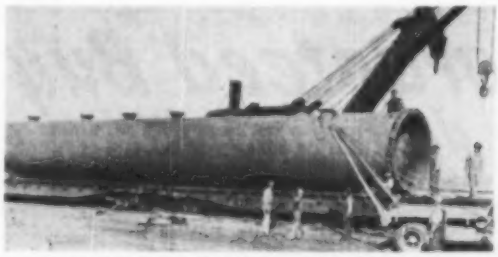
Fifty data sheets a month will be distributed until January 1 at which time 20 to 25 sheets monthly will be followed. Emphasis in the handbook is on revealing trends, short-term and particularly long-term with standard semilogarithmic charts covering the time span from 1910 to 1960. Also included are charts on population, national income, industrial production, retail sales, supply and consumption of raw materials for the chemical industry and their relation to operation.

Preparation of the handbook is under the direction of Dr. Raymond Ewell, manager of the institute's chemical economics service. Assisting him in collecting, analyzing and plotting data are members of the chemistry, library and economics staffs of the institute.

Gas Purification Research

Organic Sulfur in Synthesis Gas: Occurrence, Determination, and Removal; A. E. Sands, H. W. Wainwright, and G. C. Egleson, Bureau of Mines, Publications Distribution Section; 4800 Forbes Street, Pittsburgh 13. Free.

Progress made in the search for effective, low-cost ways of removing sulfur impurities from synthesis gas is described in a Bureau of Mines publication which deals with a part of the synthesis gas purification research program being carried out at the Bureau's Morgantown, W. Va., station in cooperation with the West Virginia University. Synthesis gas, used in the production of liquid fuels and certain chemicals, such as ammonia, alcohols and methane, must be free of impurities, the report notes. An increasing interest in the complete removal of sulfur compounds from manufactured gas is reported.



Superior-built Absorber 80 ft. long and 102 inches in diameter.

Proof! **That SUPERIOR works as a team!**

Because of close cooperation between our engineering and production departments, the above absorber was built to the satisfaction of a West Texas gasoline plant.

Superior departments always work as a team to produce your job AS YOU PLAN AND SPECIFY. Try us. We can do your jobs too!

Also
FRACTIONATING TOWERS - HEAT EXCHANGERS - SCRUBBERS AND RETUBING OF HEAT EXCHANGERS

API-ASME AND ASME CODE CERTIFIED BY NATIONAL BOARD

For Information or Estimates Call Amarillo 3-4395

SUPERIOR MANUFACTURING COMPANY
AMARILLO, TEXAS

CONTROL BY AIR POWER

. . . with the Wheelco Pneumatic Capacilog! *For safety*—where electric contactors or motors are a hazard—*for results*—where fixed position changes of fuel or medium are injurious to your product.

Get instant indication, permanent record and control with the smooth-flowing power of air—get the Wheelco Pneumatic Capacilog.

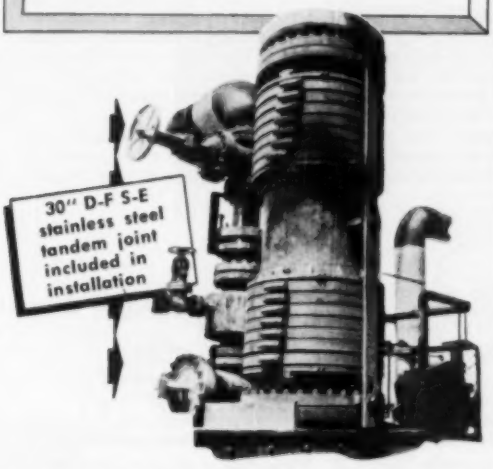
Wheelco instru*mentality* adds safety and product uniformity.

Write for Bulletin C2, Wheelco Instruments Company, 701 W. Harrison Street, Chicago, Illinois.

wheelco electronic controls

FOR ITS NEW TOLEDO REFINERY

SUN OIL CHOOSES Badger EXPANSION JOINTS



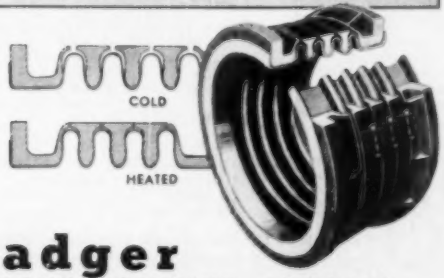
When Sun Oil Co. builds a refinery, only the best equipment is good enough. So it's no surprise to see Badger Expansion Joints at the new Toledo refinery of this giant of the petroleum industry.

The Badger Tandem Joint shown is one of several used in this installation to protect piping and equipment from damage due to both axial and lateral movements at high temperature. It is built to the famous Badger Directed-Flexing Self-Equalizing design . . . an exclusive feature that equalizes stresses between and within corrugations . . . multiplies efficiency and joint life.

Like hundreds of others, Sun Oil Co. knows from experience that these extra features in Badger Joints will keep their maintenance costs at a minimum:

- Packless . . . pressure-tight single tube
- Special forming . . . no structure-weakening stresses
- Controlled heat treating . . . assures long life
- Directed-flexing — all-curve flexing motion
- Fabricated from stainless steel or alloys for high pressure, temperature and corrosion, or from copper for normal use

Find out how Badger can save you money — write for facts today.



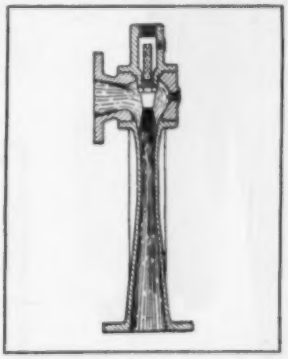
Badger
MANUFACTURING COMPANY
230-260 BENT STREET, CAMBRIDGE, MASS.

are your

- STILLS
- DRYERS
- EVAPORATORS
- CRYSTALLIZERS
- PROCESS VESSELS

OPERATING AT VACUUMS LIMITED BY THE VAPOR PRESSURE OF THE CONDENSATE?

Many stills, dryers, evaporators, crystallizers and other processing vessels are operating at vacua limited by the vapor pressure of the condensate. This means on the average an absolute pressure of about 2.0" Hg. Most owners of such equipment do not realize how practical and economical it is to put a Booster Evactor in the line between the vessel and the condenser and maintain an absolute pressure of 0.5", 0.25" or even lower. The benefits of this higher vacuum in improving quality and capacity are often very substantial.



The steam jet type of vacuum pump has continually gained in favor for high vacuum in industrial process work. The total absence of moving parts is a big advantage and means many years of service, with no maintenance cost. Available in single, two-, three-, four- and five-stage units for vacuum from a few inches up to a small fraction of 1 m.m. Hg. absolute.

Croll-Reynolds have been specializing on this type of equipment for over 30 years, and have made thousands of separate installations. Their engineers have extensive experience in applying it to numerous different processes, and are available for consultation without obligation. Literature is also available on request.

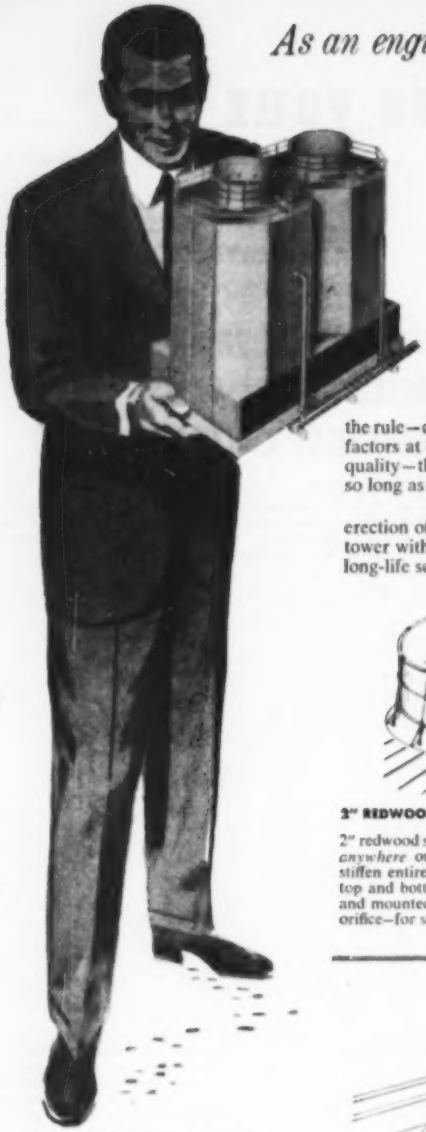
CROLL REYNOLDS

CROLL-REYNOLDS CO., INC.
17 JOHN STREET, NEW YORK 7, N. Y.

Chill-Vactors Steam Jet Evactors Condensing Equipment

As an engineer you will appreciate...

The RUGGED DESIGN
inherent in the 1950
FLUOR COUNTERFLO
Cooling Tower

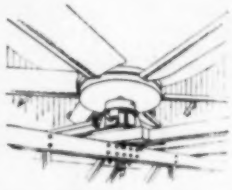


Ruggedness is a prerequisite in cooling tower design and performance. Without it, inefficiency and costly maintenance becomes the rule—drop in plant production is the end result. Regardless of the influencing factors at time of purchase—low first cost, claims of efficiency or statement of quality—the cooling tower you select will meet performance requirements *only* so long as its original structural design endures.

Thirty years' intensive development in the design, fabrication and erection of cooling towers enables Fluor to offer you a better cooling tower—a tower with comparable first cost, the highest obtainable efficiency and rugged, long-life service.

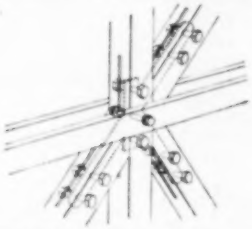
2" REDWOOD IN FAN DECK and STACK

2" redwood supports 1000#/sq. ft. load *anywhere* on deck—heavy enough to stiffen entire structure. Stack is ringed top and bottom with heavy angle iron and mounted on a metal bell-mouthed orifice—for safety and savings in power.



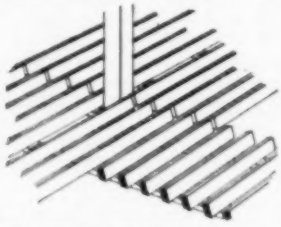
RUGGED GEAR UNIT and FAN BLADES

Gear unit is designed *specifically* for cooling tower service. Result: Less than ¼ of 1% replacement parts!
Heavy Stainless Steel Fan Blades give a larger moment of inertia—tips are strong enough to hold a man's weight.



STRONGER STRUCTURAL DESIGN

Internal gusset plate and bolt-type joints enable structural members to take *both* tension and compression loads—a design *in accordance* with the rigid requirements of major city codes and recent findings of the U. S. Forest Products Laboratory.



1" REDWOOD GRID DECK FILLING

Grid decks consist of heavy 1" redwood nailed individually on sturdy cleats—strong enough for use as scaffolding during tower erection, durable enough to permit repeated removal for cleaning or fire hosing without removing from tower.

CONSIDER THIS about "Guaranteed Performance"

Fluor's "Guarantee of Performance" is based on a true bid to meet specified performance requirements. There is an old saying, "You can't get something for nothing." This is particularly true in the purchase of cooling towers—a bid allowing performance to be off only 2 or 3 degrees on the approach may seem insignificant at time of purchase, but it can mean as much as 30 to 40% difference in the size of tower necessary to do the specified job! Often this is overlooked if a tower is purchased on price alone.

For your protection compare the probable performance of the towers offered before making a decision. Analyze your cooling tower bids thoroughly!

FLUOR

BE SURE WITH FLUOR

Technical Papers for Your Files: "COOLING TOWER STUDIES," "COOLING TOWER MAINTENANCE," "EVALUATING COOLING TOWER PERFORMANCE."

ENGINEERS • CONSTRUCTORS • MANUFACTURERS

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif. Offices in principal cities in the United States
REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

About EQUIPMENT and SERVICE Suppliers

Republic Supply Announces President and Vice President

J. H. Lollar, Jr., is new president of Republic Supply Company and H. B. Catlow, vice president in charge of sales. Both Lollar and Catlow will continue to serve on the board of directors.

Lollar

Republic Supply, which this year is celebrating its 40th anniversary of service to the oil and gas industries, operates in 47 services in nine states.

Headquarters are in National Standard Building in Houston.

United Centrifugal Agent

Richards-Conant, Denver, Colo., sales and engineering firm, has been appointed to represent United Centrifugal Pumps, a division of United Iron Works. Richards-Conant operates in New Mexico, Wyoming, Colorado, Montana and in Western portions of South Dakota, Nebraska and Kansas.

Davison Chemical Converts Cincinnati Catalyst Plant

The Davison Chemical Corporation is converting part of the capacity of its Cincinnati, Ohio, synthetic fluid catalyst plant from the ground type of production process to the spray drying method. Important to the new equipment being installed is a spray drying chamber built entirely of stainless steel. This chamber measures 22 feet in diameter by 14 feet straight shell and 30 feet cone.

The spray-drying chamber will produce a microspheroidal form of catalyst having uniform particle size distribution. Within the chamber the material is processed in counter flow with flue gas. Flue gas is supplied by an air heater, standard vertical, up-fired, pressure type, fitted to burn either oil or gas. A new washing system is also being installed.

Production is expected to be under way by October, 1950.

Eastern

HEAVY-DUTY SIDE ENTERING MIXERS

Let Eastern's engineers help you with your petroleum processing equipment problems. Without obligation to you—they will propose suitable mixing equipment and guarantee its satisfactory performance.

These rugged and dependable side-entering mixers prevent settling and bottom-precipitation. Available motor ratings 1/8—30 H.P. Speeds from 280—1725 R.P.M. Repackable while tank is full.

Write to Dept. SC for new Eastern Mixer Catalog No. 600.

Eastern INDUSTRIES, Inc.

296 ELM STREET • NEW HAVEN 6 CONNECTICUT

Farris Stacon, New Firm Formed by Farris Engineering

Farris Stacon Corporation, a new company, has been formed by Farris Engineering Corporation to purchase the Edison Stacon Regulating Division from Thomas A. Edison, Inc. (Instrument Division). Main office and plant of Farris Stacon is located in Palisades Park, N. J.

Farris

V. W. Farris, president of Farris Engineering said that basic design and construction of the regulator have been retained, but that certain points have been made more rugged and the line extended to include a six-inch size. Also acquired by the Farris firm are all Stacon patents equipment, machinery, inventory and records from Thomas A. Edison, Inc. (Instrument Division). The new company is "the nucleus of extensive plans to develop industrial instrumentation and temperature control." It will continue service to present users of Stacon regulators and controllers.

To Dallas for Oakite's Petroleum Service Division

Oakite Products, Inc., New York, has appointed J. D. Hudson to its petroleum service division staff. From offices in Dallas he will assist the company's field representatives in providing additional technical advisory service on special problems arising in connection with petroleum industry cleaning and allied operations.

Hudson

Since 1943 Hudson had been with Cities Service Oil Corporation at Lake Charles, La. He is a graduate of Mississippi State College and did postgraduate work at MIT before entering the refinery construction field in the Louisiana area in 1935.

Research Director for Ethyl Detroit Laboratory

John B. Taylor Jr. has been appointed assistant director of research at Ethyl Corporation laboratories in Detroit, to direct research on automotive and aviation products.

Taylor is a native of Virginia and a graduate of Virginia Military Institute. He joined Ethyl 19 years ago as a field engineer in Baltimore, Md., and three years later was transferred to the company's technical service activities in Detroit. For the past three years he has been executive engineer of the research laboratories.

John F. Myers Announced as New Westinghouse Supply Head

John F. Myers has been elected president of Westinghouse Electric Supply Company to succeed David M. Salsbury.

who will be vice president in charge of Texas and Pacific Coast operations with headquarters in San Francisco.

Westinghouse Electric is a wholly-owned subsidiary of Westinghouse Electric Corporation.

Penn General Sales Manager

James W. Bennett has been appointed general sales manager of Penn Industrial Instrument Corporation of Philadelphia. Bennett was graduated in 1939 from the University of Cincinnati with a degree in mechanical engineering. For the past five years he has done special engineering sales work Energy Control Company of New York and Philadelphia.

OPEN HOUSE—Recent opening of American Cyanamid Company's new research laboratories at Stamford, N. Y., was the occasion of exhibits pointing out the importance of refinery products and the processes and problems involved in their development. Pictured here is a comprehensive display of the chemical additives for lubricating oils, their uses, and the equipment in which they are tested.

Becomes Rockwell Executive Of Meter and Valve Division

Rockwell Manufacturing Company has appointed L. A. Dixon, Jr., assistant vice president of the meter and valve division to assist in the coordination of sales and factory problems. Headquarters will be in Pittsburgh. For the past two years Dixon has been the general manager of the Pittsburgh-DuBois Division of Rockwell.

Dixon

Dixon has been with the meter industry since his graduating from Pennsylvania State College. He was commissioned by the U. S. Department of Commerce to make reports on Europe on German, French and English gas meter methods and designs. He also surveyed the gas industry in all South American countries.

New Engineering Company Turns Out Refinery Fittings

Heading the new firm of Burkhart Engineering Company, 1221 Locust Street, St. Louis 3, is Merle E. Burkhart, mechanical engineer. The firm has been established to design and manufacture oil refinery fittings (return bends). Incorporators besides Burkhart are K. P. Wesseling and H. H. Stern. Officers are Wesseling, vice president and treasurer; Stern, secretary; W. W. Blase, assistant secretary; and H. Schlarman, west coast office, 6738 Hollywood Boulevard, Hollywood, Calif.

Burkhart

Burkhart is a registered professional engineer of Missouri and was formerly with Key Company, East St. Louis, Ill. This firm he served as chief engineer, vice president in charge of engineering and vice president in charge of sales. He was with K. P. Wesseling Company, machinery dealer, St. Louis, since 1945.

Wheelco Placements Include District Managerships

Wheelco Instruments Company, Chicago, has opened sales offices in Grand Rapids, which will cover Michigan, with the exception of Detroit. R. P. Campbell, sales engineer, will be in charge as assistant district manager. The new office will operate under the supervision of Detroit.

Don C. Walley, formerly sales engineer with the Chicago western division office, has been appointed St. Louis district manager. Warren F. Paetz, sales engineer, will take over Walley's former territory of central Illinois and Iowa.

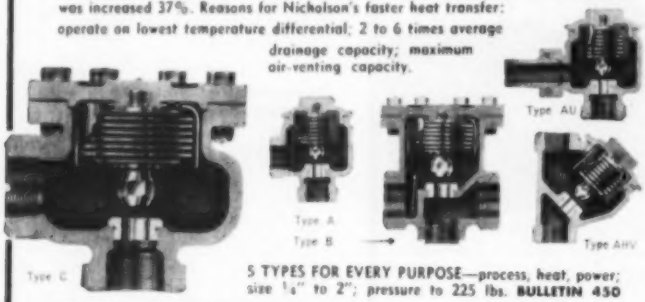
Samuel M. McDevitt, Philadelphia service engineer recently sent to the

Well-Known Processor

Puts 37% More Thru Cookers

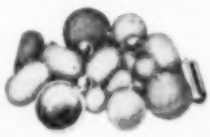
With Nicholson Steam Traps

A leading drug manufacturer found that a recent Nicholson thermostatic steam trap installation, replacing a mechanical type, so cut kettle time that their production was increased 37%. Reasons for Nicholson's faster heat transfer: operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air-venting capacity.



5 TYPES FOR EVERY PURPOSE—process, heat, power; size 1/4" to 2"; pressure to 225 lbs. BULLETIN 450

HIGH-PRESSURE FLOATS—Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.



W. H. NICHOLSON & CO.

207 Oregon St., Wilkes-Barre, Pa.

SPEED TUBE MAINTENANCE

. . . with the WILSON-DUDGEON *Model 50 Refinery Expander*

YOU CAN BE SURE of fast easy rolling and solid seating of furnace, still and other heavy wall tubes with the specially designed self-feeding and parallel rolling Wilson-Dudgeon Refinery Expander. These expanders are available in multi-roll types, with and without flare rolls, thrust collars and "ironing-out" attachments. There is a Wilson-Dudgeon Expander available for any type of refinery fitting.

Model 50 Refinery Expander

. . . with the WILSON *EP Series Air Motor and Model R Cutter Head*

Wilson EP Series Air Motor with Model R Cutter Head

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Sier-Bath Gearex Pump. Capacities: 1-550 GPM Discharge: 50 PSI for water

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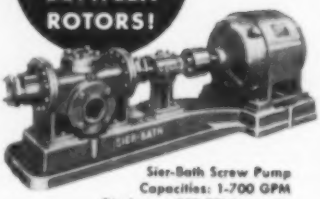

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Capacities: 1-700 GPM
Discharge: 250 PSI for water

LOWER ORIGINAL COST — High pressures developed by small volume Sier-Bath Pumps eliminate need for over-size pumps, expensive throttling valves. Positive displacement lessens need for costly metering valves.

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FOUNDED 1905 MEMBER A.G.M.A.

Sier-Bath
GEAR and PUMP CO., Inc.

9165 HUDSON BOULEVARD NORTH BERGEN, NEW JERSEY

New York eastern division office has been replaced by Edward F. O'Brien.

Tom Mitchell, service engineer in New York, has been sent to Boston.

Owens-Illinois Glass Gets Two Kaylo Sales Engineers

Smith

Dathe

Robert L. Smith and Fred A. Dathe have been named sales engineers for the Kaylo Division, Owens-Illinois Glass Company.

Smith has been assigned the Cincinnati territory, which includes southern Ohio, Indiana and West Virginia, as well as a part of Kentucky. He was vice president and sales engineer of Reardon Industries, Cincinnati, before joining Owens-Illinois early this year.

Dathe will assist J. D. Hailey, working from the company's general office in Toledo and covering a territory which includes northern Ohio and Indiana and the entire state of Michigan. He was formerly with National Gypsum Company.

Babcock & Wilcox Build Pennsylvania Extrusion Plant

A new extrusion plant for the fabrication of tubes of ferrous metals and alloys in complex sectional shapes, will be constructed on the site of present facilities in Beaver Falls, Pa., for The Babcock & Wilcox Tube Company. The announcement followed completion of a licensing agreement between B&W Tube and Comptoir Industriel d'Etirage & Profilage de Metaux of Paris, France, developers of the process and holders of the patent rights.

The process fabricates alloys by the rolling or forging methods producing hollow and solid sections of complicated shapes. The key to the process is a new concept of lubrication of hot metal which solves the problem of lubrication and thermal insulation of the die and ingot holder. The extruded operation is carried out in a few seconds and at constant temperature, giving the extruded product uniform mechanical characteristics throughout its entire length.

Fisher Scientific Acquires Tagliabue Oil Equipment

Acquisition of complete stocks, tools, dies and full rights to the petroleum equipment of C. J. Tagliabue Company of Newark, N. J., is announced by Fisher Scientific Company. Included among the instruments to be manufactured and sold by Fisher Scientific under the tradename Fisher-Tag are flash point testers, viscosity meters, oil color testers, and cloud-and-pour-point apparatus.

Fisher Scientific also maintains plants in New York, St. Louis, and Montreal.

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Worthington Posts Filled By Veteran Sales Engineers

Meiter

Stovall

A newly created position of central sales manager, directing the sales of Buffalo, Detroit, Cleveland, Cincinnati and Pittsburgh offices of Worthington Pump and Machinery Corporation, has been filled by William A. Meiter. John W. Stovall succeeds Meiter as manager of the Buffalo district sales office.

Meiter joined Worthington's training class in 1927 after graduation from Ohio State University with a mechanical engineering degree. He was named manager of the Buffalo office in 1938.

Stovall has been with the company 21 years. He attended Carnegie Institute of Technology.

Becomes Peabody Manager Of New Chicago Offices

Peabody Engineering Corporation of New York has named Allen H. Jones manager of the newly-opened Chicago office. Although Peabody Engineering maintains offices abroad, the Chicago office is the first company-operated district in the U. S.

Jones

The firm manufactures industrial burners, gas scrubbers, coolers, and absorbers. New Chicago offices will enable more direct handling of field engineering assignments.

Ernest H. Peabody is president and founder of the corporation.

Honeywell Announces New Promotions and Additions

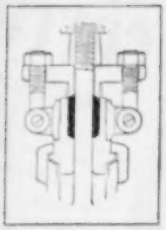
Promotions and additions affecting its field staffs, industrial and valve divisions have been announced by Minneapolis-Honeywell Regulator Company as follows:

Charles F. Woods named valve division sales manager for the southwest region, headquarters in Dallas; Edward J. Byrne, formerly with the Houston branch, succeeds Woods as industrial manager, Dallas; Howard W. Griesbach appointed industrial manager of the Milwaukee branch.

Additions to the field sales staffs include: Louis C. Schultz to Chicago, and William E. Van Horne to Rochester, for industrial sales; William J. Kirby to Los Angeles, and P. R. Vogel to Houston, on industrial supplies sales.

Transfers of field men include: Lawrence E. Kennedy, transferred from Syracuse to Atlanta, Ga.; George Mas-

Makes Any Valve A Packless Valve



Chemiseal 810W TEFLON Packing

- *Defies All Chemical Attack*
- *Reduces Torque on Spindle*
- *Will Never Freeze a Valve*

Here's a valve packing that's absolutely chemical-proof, lasts indefinitely, seals at low gland pressure and won't freeze a valve no matter how long unoperated.

Chemiseal 810W packing is made of solid Teflon. Teflon is *chemically inert*, can't be attacked by nor contaminate *any* process material. It's physically tough and suitable for temperatures from −150° F. to 550° F. Also, Teflon has unique natural slipperiness that insures free spindle operation at all times.

Note the cup-and-cone design of 810W packing. When pressure is applied, cones deform *inward* against the spindle, while cups expand *outward* against the stuffing box. This flexing gives the solid Teflon a mechanical resiliency that permits a tight seal at low gland pressure, reducing torque required to operate the valve.

When you order new valves from your valve manufacturer (within the service range indicated above), specify "Chemiseal 810W Teflon Cup-and-Cone Packing." Permanent, trouble-free service will more than justify the additional cost. Write for Catalog No. 810W.

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sey, from Atlanta to Nashville, Tenn.; A. R. King, from Boston to Worcester, Mass.; Gerald G. Walker, from Detroit to Saginaw, Mich.; W. J. Kilroy, from Detroit to Grand Rapids; and John Koerner, from Pittsburgh to Youngstown, Ohio. Carl Bohnlein has been transferred from general to industrial sales at Philadelphia, and George Jensen has been transferred from Chicago industrial service to industrial sales at Menasha, Wis.

Manages Western Sales Of Ethyl Corporation

Meredith (Ted) Littlefield, sales coordinator in charge of the San Francisco office, has been appointed manager of the western sales region of Ethyl Corporation. He succeeds Sanford M. Wagner, recently elected vice president in charge of sales.

Littlefield

The western region has Los Angeles headquarters and includes California, Washington, Oregon, Montana, Wyoming, Utah, Idaho, Nevada, and Arizona.

Littlefield has been with Ethyl 21 years on sales assignments in New York, Mexico and South America before being transferred to the San Francisco office in 1940. He is a native of Maine and attended Massachusetts Institute of Technology.

Kennedy Tilco-Fin Division Appoints District Agent

Brock Mott has ben appointed district representative of Tilco-Fin Division, David E. Kennedy, Inc., Brooklyn. Mott's territory will include Texas, Oklahoma, Kansas and Nebraska.

He attended the engineering school of the University of Tulsa and is a graduate of the U. S. Naval Academy at Annapolis. Previous positions have been as engineer for Pressed Steel Car Company's armored tank division, Chicago, and Joseph A. Coy & Company, Tulsa. He also established Brock Mott Company, manufacturers' agents and sales engineers, Tulsa.

Engineering Director Named For MM&M Hancock Valves

Erling Klafstad has been appointed assistant director of engineering for Hancock Valves and Consolidated safety and relief valves of Manning, Maxwell & Moore, Inc. Born in Norway, Klafstad attended Oslo Technical, Norway Franklin Institute, Lowell Institute, and the Massachusetts Institute of Technology. Previously he was vice president in charge of engineering and manufacturing for Crosby Steam Gage and Valve Company. He will make headquarters in the Bridgeport, Conn., plant.

Bristol Engineer Rejoins

R. M. Brown, formerly sales engineer with Bristol Company of Canada, Ltd., has rejoined the firm and will be stationed at Baltimore, Md. He was lately instrumentation engineer with Stadler Hurter & Company, Montreal, consulting engineers.

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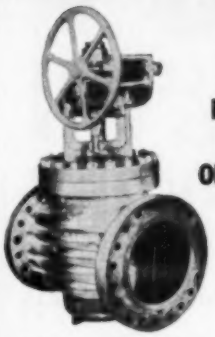
ALL PURPOSE
STEEL VALVES

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Insul-Mastic Appoints Four New Sales Licensees

Insul-Mastic Corporation of America has appointed four new licensees to its national sales organization. Two of these firms, General Building Maintenance Company, 409 Elm Street, Buffalo 3, N. Y. and Claude A. Woodard, 2423 East 14th Place, Tulsa, will be engaged in the application of Insul-Mastic weatherproof coatings to the exteriors of homes and commercial buildings.

The other two companies, H. S. Chaffee Company 220 Scott Street, Buffalo 11, N. Y. and W. F. Magann, 2420 High Street, Portsmouth, Va., will make applications of Insul-Mastic corrosion prevention, vapor-sealing and insulating coatings in industrial plants.

New Houston Firm Specializes In Refinery Equipment Design

Formation of Russell Engineering Corporation with offices at 2521 Wroxton Road, Houston, is announced by George F. Russell, president. The firm specializes in the design and engineering of natural gas and petroleum processing equipment. Other officers are Warren N. Richey, vice president and chief engineer; and James M. Hoover, executive vice president and secretary treasurer.

Russell was formerly associated with Hudson Engineering Corporation, Esso Standard Oil Company, Phillips Petroleum Company, and Consolidated Western Constructors, Inc. For the past two years he has been a consulting chemical and petroleum engineer.

Russell was assistant professor of chemical engineering at the University of Oklahoma and was associate professor of natural gas and petroleum engineering at LSU.

Alloy Steel Products Agent

S. W. Collins has been appointed Alloy Steel Products Company sales representative for the states of Oklahoma and Kansas with offices in Tulsa. Previously Collins was in New York where he represented Pacific Valve Company. As assistant district manager for Oklahoma Refinery and Machinery Company he was in the Oklahoma area.

GE Promotes Keller

J. P. Keller, formerly superintendent of all generator and turbine bucket manufacturing for the turbine division of General Electric Company's apparatus department, has been appointed as assistant to the manager, industrial divisions. Replacing Keller is L. E. Newman, previously assistant manager of the Lynn, Mass., turbine and gear sales division.

Skinner Adds Indiana Plant

The M. B. Skinner Company, South Bend, Ind., manufacturers of pipe repair clamps and saddles, has broken ground for a plant addition which will increase production space by 50 percent.

Maloney Tulsa Office Opens

Frank L. Mill has been named district manager of F. H. Maloney Company's new branch office in Tulsa. The office, at 310 Thompson Building, will represent the Mid-Continent area of Oklahoma, Kansas, Missouri, and the adjacent territory.

Retained as general manager in Houston is Edward W. Upton. The firm also has a branch office in Los Angeles besides four factories located in Houston since 1932.

PETROLEUM REFINER CLASSIFIED ADS

RATES for Classified Ads are $8 per column inch. Minimum size one column inch. In smallest type size, figure 50 words per inch. **Situations Wanted $4 per column inch. All classified ads payable in advance.** Ten percent discount if three or more insertions are ordered at same time. **COPY DEADLINE** is 25th of month preceding date of issue. Send copy and checks to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

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Excellent opportunity in well-known oil refinery company. Graduate engineer preferred.
Must have heavy experience in oil refinery, chemical plant or power plant piping.
Write details of education and experience to Box 176-R, c/o Petroleum Refiner, Houston, Texas.

Quick Results from Refiner Classifieds

Hammel-Dahl Executive Dies

Bruce A. Irwin, 48, vice president and general manager of Hammel-Dahl Company, Providence, R. I., died suddenly June 14. Irwin was active for 20 years in the design and development of automatic flow control valves in the chemical, petroleum and process industries. He had been associated with Hammel-Dahl as vice president and general manager since 1946. During the war he was secretary of the Materials Co-ordinating Committee of the Petroleum Administration and was chief of the PAW Materials Requirements Section.

Irwin

National Technical Now Beckman Instruments, Inc.

Beckman Instruments, Inc., is the new name of National Technical Laboratories, manufacturers of the Beckman pH meters, spectrophotometers, automotive titrators and other scientific and industrial instruments. No other changes are involved, either in company organization, policies, personnel, products, or locations of factory and service branches in New York, Chicago, and South Pasadena, Calif.

Officers for Morris Company

C. F. Maroney has been elected president of Morris Coupling and Clamp Company, Ellwood City, Pa. R. W. McGrew was named secretary.

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for All Kinds of Service, etc.
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* The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1950 Refinery Catalog.

A

*The Air Preheater Corp. 26
Air Reduction Magnolia Co. 32
*Airetool Manufacturing Co. 176
*Allis-Chalmers Manufacturing Co. 27
*Alloy Steel Products Co. 46
*Aluminum Company of America 6, 175
American Brass Co. 69
American Iron & Machine Works Co. 170
*American Locomotive Co. 16
American Petroleum Institute 139
American Smelting & Refining Co. 187
The Amsin Co. 169
*Armstrong Machine Works 5
*Attapulgus Clay Co. 150
*Aurora Pump Co. 174

B

*The Babcock & Wilcox Co. 33
*E. B. Badger & Sons Co. 36-37
*Badger Manufacturing Co. 193
W. H. & L. D. Betz 22
*Black, Sivalls & Bryson, Inc. 49
*Blaw-Knox Co. 152, 174
*Born Engineering Co. 76
Bridgeport Brass Co. 131

C

Calumet & Hecla Consolidated Copper Co. 51
The Chapman Valve Manufacturing Co. 18
Chase Brass & Copper Co. 71
*Chemical Construction Corp. 50
Chicago Bridge & Iron Co. 14
Classified Advertising 201
*Corning Glass Works 199
*Crane Co. 35
*Croll-Reynolds Co. 193

D

*Dean Brothers Pumps Inc. 151
The Dow Chemical Co. 59
Dowell Incorporated 182
*Dresser Industries, Inc. 142
E. I. du Pont de Nemours & Co. ..... 62, Insert 128-129
*The Duraloy Co. 155
Durametallic Corp. 162

E

*The Eagle-Picher Co. 11
*Eastern Industries Inc. 195
Electric Steel Foundry 41
Ellerbee Bros. 24
*Elliott Co. 72, 127
*Engineers & Fabricators, Inc. 38
*Ernst Water Column & Gage Co. 201
Ethyl Corp. 44-45

F

Federated Metals Division American Smelting & Refining Co. 187
*Fisher Governor Co. 30
*Flint Steel Corp. 168
*The Fluor Corp. 194
*Foster Wheeler Corp. ..... Insert 160-161
The Foxboro Co. 47

G

*The Garlock Packing Co. 29
*General American Transportation Corp. 156
*General Electric Co. 12-13, 140-141
A. J. Gerrard & Co. 200
*The Girdler Corp. 21
*Goslin-Birmingham Mfg. Co. 191
Graver Tank & Mfg. Co. 153
Graver Water Conditioning Co. 33

A. F. Green Fire Brick Co. 19
*Grinnell Co. 177
*The Gulf Publishing Co. 55, 147

H

D. W. Haering & Co. 161
Hagan Corp. 181
Hammel-Dahl Co. 25

I

*Industrial Division Minneapolis-Honeywell Regulator Co. 172
*International Engineering, Inc. 180
The International Nickel Co. 61

J

C. O. Jelliff Mfg. Corp. 180
*Johns-Manville 31
*The Johnston & Jennings Co. 164

K

Kaylo Division Owens-Illinois Glass Co. 203
*Keasbey & Mattison Co. 40
*The M. W. Kellogg Co. ..... Insert 32-33, 185
*The C. M. Kemp Mfg. Co. 173
Kinney Manufacturing Co. 178
*Klingerit, Incorporated 188
*The Koch Engineering Co. 43

L

Layne & Bowler, Inc. 197
*Leeds & Northrup Co. 8
Lukens Steel Co. 148
*The Lummus Co. ..... Insert 16-17

M

Manning, Maxwell & Moore, Inc. 15
*The Marley Co. 163
*Mason-Neilan Regulator Co. 2-3
The Master Electric Co. 34
*A. Y. McDonald Mfg. Co. ..... IV Cover
*Arthur G. McKee & Co. 133
Metal Textile Corp. 25
*Midwest Piping & Supply Co. 170
*Minneapolis-Honeywell Regulator Co. 172
*Murray Iron Works Co. 146

N

The Natasco 158
*National Airoil Burner Co. 200
*National Carbon Division Union Carbide and Carbon Corp. 166
*W. H. Nicholson & Co. 196
*Nooter Corp. 60
*W. C. Norris, Manufacturer, Inc. 57

O

*Oakite Products, Inc. 160
Oil Industry Information Committee 139
Orbit Valve Co. 145
Owens-Illinois Glass Co. 203

P

*Page Steel & Wire Division American Chain & Cable Co. 60
*Palmer Thermometers, Inc. 28
*Perco Division Phillips Petroleum Co. 30
*Petro-Chem Development Co. 54
*Phillips Petroleum Co. 30
*Pomeel Corp. 150
The Wm. Powell Co. 10
*The Pressed Steel Co. 17
*J. F. Pritchard & Co. 186

R

Reading-Pratt & Cady Division American Chain & Cable Co. 58
The Refinery Engineering Co. 136
*Republic Steel Corp. 29
*The Ric-Wil Co. 135
*Rockwell Manufacturing Co. 64
*Rockwood Sprinkler Co. 48
*Roots-Connersville Blower Corp. 142
Rust-Oleum Corp. 190

S

Santa Fe Railway 154
Shand & Jurs Co. 159
Sier-Bath Gear & Pump Co. 198
The Edward Soph Co. 187
Stanolind Asphalt & Bitumuls Co. 198
*San Shipbuilding & Dry Dock Co. 204
Superior Manufacturing Co. 192

T

*The Terry Steam Turbine Co. 56
The Timken Roller Bearing Co. 4

U

*Union Carbide and Carbon Corp. 166
United States Gasket Co. 199
Universal Oil Products Co. 200

V

Visco Products Co. 55
*Henry Vogt Machine Co. 52
J. H. H. Voss Co. 178

W

*Wallace & Tiernan Products, Inc. 7
Walworth Co. 42
Warren Petroleum Corp. ..... I Cover
*Watson-Stillman Co. 149
Wedgeping Valve Co. 200
Well Equipment Mfg. Corp. 171
Wheelco Instruments Co. 192
Wilson Products, Inc. 165
Thomas C. Wilson, Inc. 197
Wolverine Tube Division Calumet & Hecla Consolidated Copper Co. 51
*Worthington Pump & Machinery Corp. 163
Wyatt Metal & Boiler Works ..... III Cover

Y

*Yarnall-Waring Co. ..... II Cover

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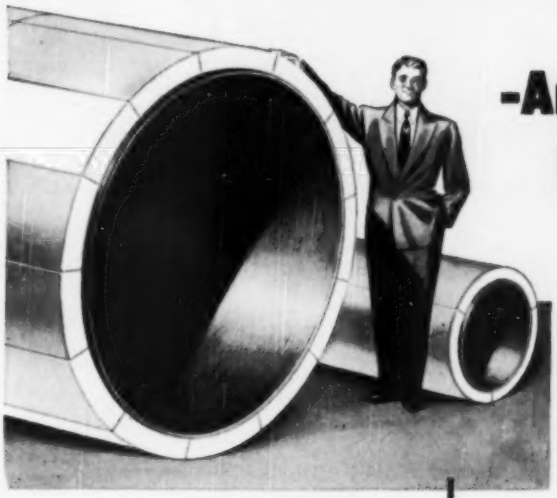

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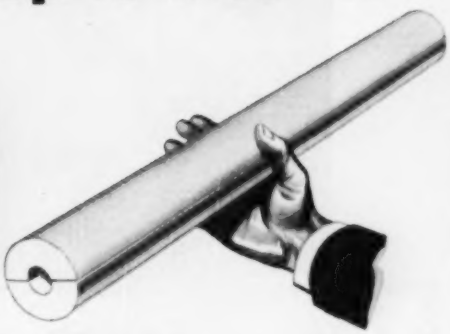

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K-SEGMENTAL
For pipes, vessels or tanks from 38" to 72" in diameter.

KAYLO PIPE INSULATION is produced in Simplified Dimensional Standards of thicknesses, diameters and shapes for snug nesting, when necessary. O. D.'s of insulation correspond to O. D.'s of standard pipes. All sections are 36 inches long. Single-layer thicknesses range from nominal 1" through 4".

Here is one proved pipe insulating material that is efficient throughout a wide temperature range–up to 1200°F. Kaylo Pipe Insulation is a calcium-silicate material which is highly resistant to damage from water vapor or moisture. It retains its dimensional stability and efficiency in long service. It is not a glass product.

Kaylo Pipe Insulation is available for pipe sizes from ½ inch to 72 inches. It is made to close dimensional tolerances to assure proper fit for each pipe size and for all operating conditions. Higher strength and lighter weight make it easier to handle and apply.

It will pay you to investigate all of the advantages offered by Kaylo Pipe Insulation. Get the facts now.

KAYLO®

PIPE INSULATION AND HEAT INSULATING BLOCK

OWENS-ILLINOIS GLASS COMPANY
Kaylo Division • Toledo 1, Ohio

SALES OFFICES
Atlanta • Boston • Buffalo • Chicago • Cincinnati • Houston • Minneapolis • New York
Oklahoma City • Philadelphia • Pittsburgh • St. Louis • Toledo • Washington

SEND COUPON FOR KAYLO HEAT INSULATION LITERATURE

OWENS-ILLINOIS GLASS COMPANY
Dept. N-89, Kaylo Division • Toledo 1, Ohio

Gentlemen: Please send me descriptive literature on Kaylo Heat Insulation.

NAME .....

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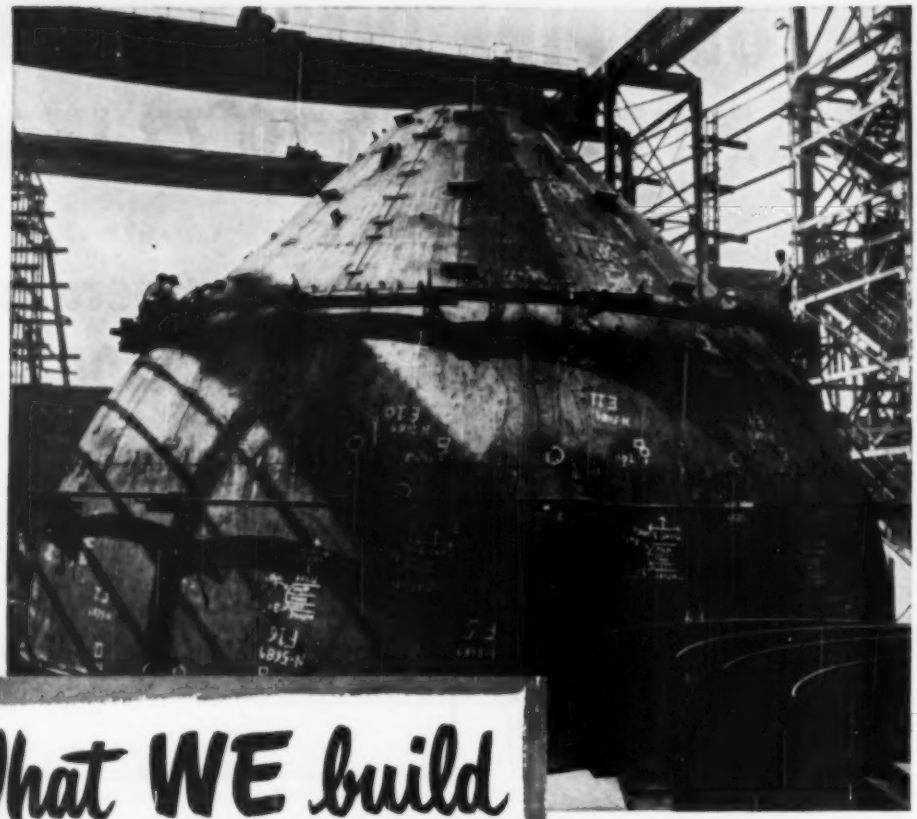


What WE build we build good

This is not a part of a ship or marine vessel, nor the nose of a huge torpedo. It is a section of a 55 foot diameter oil refining unit. It is being built in our plant where a large variety of similar equipment is built each year as regular products of this plant. Note the true shape and the accurate fits. Because of our vast facilities and long experience no job is too large and "what we build we build good."

Sun

SHIPBUILDING & DRY DOCK COMPANY

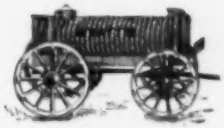
ON THE DELAWARE SINCE 1916 CHESTER, PENNA.

25 BROADWAY • NEW YORK CITY

if he could look back HE'D BE PROUD . . .

Thirty-seven years ago W. J. Wyatt fashioned storage and wagon tanks from galvanized iron in a small shop at Dallas. Truly he was a pioneer industrialist in his line. With a few ambitious workers, a few shop tools and some good ideas he laid plans for bigger things.

Today many hundreds of skilled craftsmen in Wyatt's Houston and Dallas plants are fabricating those bigger things. Backed by all that modern science offers in machines and methods, they are turning out huge vessels as shown below and all the other massive and complex steel plate fabrications found in the petroleum, chemical and other heavy industries today.



Wyatt 225-gallon galvanized corrugated wagon tank. It took two horses to pull it.

Wyatt 220-ton fractionating tower. It took three railroad cars to haul it.

Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA

'CUSHION-CLOSING' *ends* SHOCK AND HAMMER

Time-Tested McDonald Valves Save Costly Line Equipment

Plate 945
Straight Type

Thousands of users will tell you the McDonald Slo-Self Closing Loading Line Valves are the one positive, permanent way of eliminating the destructive shock and hammer imparted to pressure lines when ordinary valves are suddenly closed . . . These time-tested valves *cannot* "bang shut" because the valve plunger is hydraulically controlled . . . This is a time to guard against costly damage to expensive line equipment—a time to make sure that McDonald Slo-Self Closing Valves are installed wherever loading is done under high pressure . . . Ask for full details.

A. Y. McDONALD MFG. CO.
"The Home of the Swing Joint"
DUBUQUE, IOWA
There's a McDonald Branch or Distributor Near You

Plate 967
Adjustable Handle

Plate 956
Angle Type

McDonald Slo-Self Closing Loading Line Valves feature cushion closing, easy opening, full flow. Adjustable to operating pressures. Available in hold-open and stay-open types. All-bronze except for malleable iron handle and steel roller. Sizes: 2", 2½", 3".

For Low-Pressure or Gravity Loading...The McDonald Self-Closing Loading Line Valve

A leak-proof, full-flow valve designed to give a cushion closing effect. Elimination of "belly" at valve bottom provides a straight waterway and increases volume. High-grade bronze body—malleable iron cam and handle—steel stem. Sizes 2", 2½", 3".

Plate 902

Plate 988

McDONALD VACUUM BREAKER—for loading lines. Permits automatic and instant draining of fill pipes. Leak-proof construction. All-bronze except for composition disc. Size ⅜".

McDONALD